NORTHEAST ELECTRONICS

Division of nt northern telecom

Airport Rd., Concord, N.H. 03301•(603) 224-6511•TELEX 94-3453

INSTRUCTION MANUAL

PRINTED IN U.S.A.

MODEL 7007

T1 LINE SIGNAL GENERATOR/ POWER SUPPLY

No. A7007-00-600 ISSUE 2 DATE JUNE 1977

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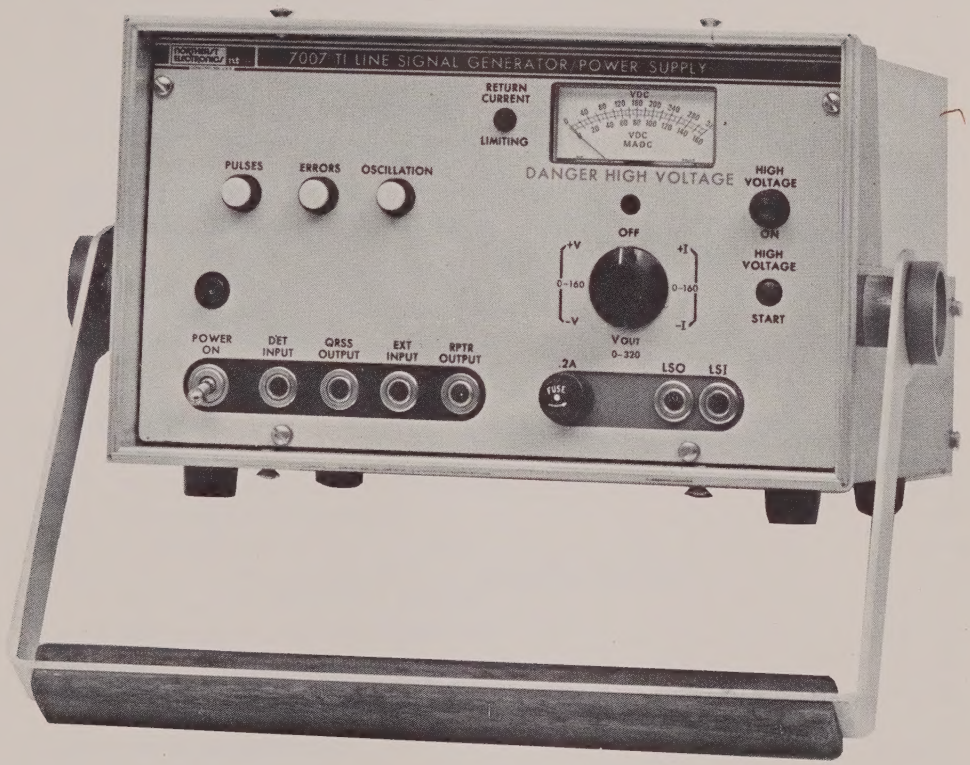
WARNING

When the Model 7007 high voltage power supply is in operation, dangerous high voltages are present on the span line power distribution system and within the 7007 itself. Exercise due caution when using or maintaining this piece of equipment.



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SECTION 1

DESCRIPTION

1.1 INTRODUCTION

1.2 The Northeast Electronics Model 7007 T1 Line Signal Generator/Power Supply is a portable send/receive instrument plus a span line power supply for testing SLC-40 and T1 PCM carrier systems. See Figure 1—1 for a simplified functional block diagram of the unit. The 7007 generates an error-free, quasi-random test signal for transmission into a PCM carrier line. It also monitors the return line to detect the presence of pulses, bipolar violations and oscillations. Span lines are powered with a constant current and the resulting currents and voltages monitored on a meter.

1.3 SPAN LINE POWERING

1.4 In SLC-40 Subscriber Carrier applications, the 7007 permits simultaneous powering and troubleshooting of span lines that have been removed from service by the SLC-40 automatic protection switching equipment. This can be done from either the Central Office Terminal (COT) or from the Remote Terminal (RT). Regular T1 span lines can be powered from either end as required providing the precautions outlined in Section 4 are observed. A customer-supplied 209-type repeater must be installed to complete the powering loop. The constant current output is preset at the factory to 140 milliamperes, but an adjustment allows the current to be set within the range of 50 to 160 milliamperes. Return line current is limited to a nominal 165 milliamperes with limiting being indicated by a front-panel lamp. Span line voltage is limited to 260 volts total across the powered line and 270 volts open circuit.

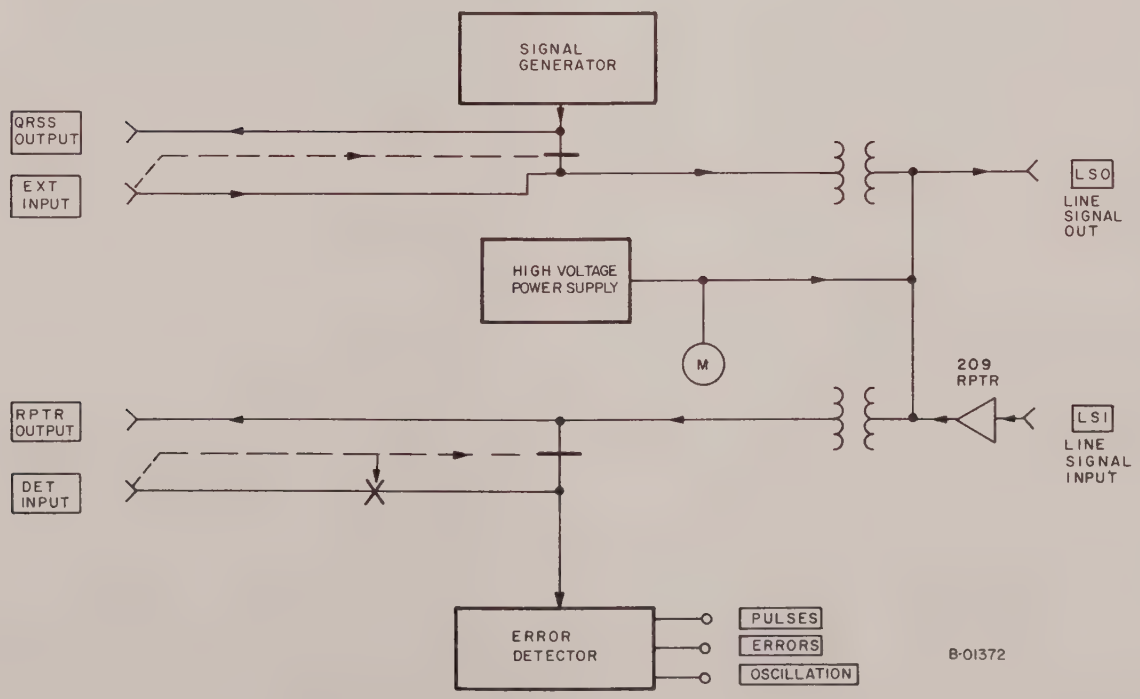

Figure 1—1. Model 7007 Simplified Functional Block Diagram

1.5 SIGNAL GENERATOR

1.6 An internal QRSS (Quasi-Random Signal Source) generator operating at 1.544 Megabits per second produces an error-free, quasi-random, bipolar test signal that is 1,048,575 bits in length. The pattern is limited to a total of 14 successive zeros. This signal can be used to troubleshoot a PCM span line by monitoring it at either end or at intermediate repeater stations. A portable error detector such as the Northeast Electronics Model 7005 T1 Bridging Error Detector can be used for intermediate repeater monitoring.

1.7 Two output ports are available. One has the simplexed span line power with the test signal superimposed on it and the second (QRRS OUTPUT) has the full-strength test signal only. In place of the internal signal generator, an external source can be connected to the EXT INPUT jack. It then becomes the signal source for the span line. It must be a full-strength signal.

1.8 ERROR DETECTOR

1.9 The built-in error detector and associated lamps provide a visual indication of the signal present at either the LSI (Line Signal Input) or the DET INPUT jacks. Lighted combinations of the PULSES, ERRORS, and OSCILLATION indicators allow determination of either a normal PCM signal (with or without bipolar violations), 10 kHz oscillations or all ones oscillations. Simultaneous flashing of both the OSCILLATION and ERRORS lamps indicate the presence of 10 kHz oscillations while flashing of both the OSCILLATION and PULSES lamps indicate all ones oscillations. The usual cause of 10 kHz oscillations is self regeneration in 201/205 type repeaters operating under a no-signal condition. Side 1/side 2 crosstalk in repeaters is ususally the cause of all ones oscillations.

1.10 LOOPING

1.11 Normally RPTR OUTPUT jack J4 provides an internal 100-ohm load for the repeater output. It also provides access to the internal repeater output for use by external equipment. To obtain the full repeater output level, a 100-ohm load must be used. The LSI input can be looped back onto the span line through the LSO jack simply by interconnecting RPTR OUTPUT jack J4 and EXT INPUT jack J3.

1.12 SAFETY AND PROTECTION FEATURES

1.13 The 7007 will power a span line only if a sleeve ground is present at both the LSO and LSI jacks. All connections must be completed before the high voltage is available. A separate HIGH VOLTAGE START push-button is provided as an additional safety feature. This causes a large, red lamp to be lighted as a reminder that dangerous high voltages are present in the set. When the set's top cover is removed, a mechanical interlock switch removes the 117 Vac power input to render the 7007 inoperative.

1.14 Internal circuits protect the 7007 from overcurrent, overvoltage, and overheated conditions. The unit is capable of operating into a short circuit load at turn on. Both the LSO and LSI ports are protected by lightning arrestors.

1.15 POWER REQUIREMENTS

1.16 The Model 7007 operates from 117 Vac ± 10%, 60 Hz and consumes approximately 94 watts.

SECTION 2

SPECIFICATIONS

2.1 INTRODUCTION

2.2 This section provides the specifications for the Model 7007 T1 Line Signal Generator/Power Supply.

Table 2—1. Model 7007 Specifications

TRANSMITTER SECTION	
Clock Frequency:	1.544 MHz ± 200 Hz
Signal Format:	Error-free quasi-random pattern 1,048,575 bits long. Limited to 14 successive zeros.
Outputs:	One unpowered output and one output with simplexed dc span line power.
Pulse Amplitude:	3 volts ± 10% ground-to-peak; 6 volts peak-to-peak into 100-ohm termination.
Pulse Width:	0.324 microsecond ± 10%.
RECEIVE SECTION	
Signal Input:	From a terminated repeater output or from a standard T1 office repeater MON jack using a 310-to-310 cord less than 6 feet long.
Impedance:	Approximately 2100 ohms, bridging, dc-blocked transformer.
Detection/Indication:	PULSES indicator: flashes approximately 10 times per second when T1 signal is present. ERRORS indicator: flashes once per bipolar violation up to a maximum of 10 per second, also flashes when 10 kHz oscillations are present. OSCILLATION indicator: flashes approximately 10 times per second when either all ones or 10 kHz oscillations are present.
POWER SUPPLY SECTION	
Output Current:	Normally set to 140 milliamperes; variable from 50 to 160 milliamperes provided output voltage limit is not exceeded.
Current Regulation:	±2.5 milliamperes at 140 milliamperes load current from 147 to 1860 ohm load resistance.
Ripple:	1 volt peak-to-peak maximum at 140 milliamperes into 1000 ohms measured from LSO to LSI jacks.

Table 2—1 (cont'd)

Return Current Limiting:	Current into LSI jack limited to 165, −10, +15 milliamperes at 60 Vdc.
Load Resistance:	280 to 5200 ohms at 50 milliamperes; 125 to 1625 ohms at 160 milliamperes.
Output Voltage Limiting:	Voltage between LSO and LSI jacks limited to 270 Vdc, ±1.5 Vdc at no load.
Voltage at LSI Jack:	Clamped at −135 ± 5 Vdc with respect to chassis ground.
Voltage at LSO Jack:	Varies from −115 to +125 Vdc at no load.
Meter Scales And Accuracy:	Output current (+I): 0 to 160 milliamperes ± 5% of full scale.
	Return current (−I): 0 to 160 milliamperes ± 5% of full scale.
	Total output voltage (V OUT): 0 to 320 volts ± 5% of full scale.
	Positive voltage (+V): 0 to +160 volts ± 5% of full scale.
	Negative voltage (−V): 0 to −160 volts ± 5% of full scale.

GENERAL

Operating Temperature Range:	−10°C to +50°C up to relative humidity of 90%. Thermostat removes 117 Vac input at +85°C. Closes at +75°C.
Storage Temperature Range:	−40°C to +70°C.
Power Requirements:	117 Vac ± 10%, 60 Hz, 94 watts.
Size:	10½ in. w x 6½ in. h x 12¼ in. d (26.7 cm x 16.5 cm x 31.1 cm).
Weight:	15 pounds (6.8 kg).

SECTION 3

INSTALLATION

3.1 INTRODUCTION

3.2 This section provides information needed to install a repeater in the 7007 and to select a span line test cord. The Model 7007 is a portable unit and does not require any special installation instructions.

3.3 REPEATER INSTALLATION.

3.4 Installation of a type 209A/B customer-supplied repeater is required to obtain full utilization of the 7007's capabilities. The repeater completes the span line powering loop and the signal path from the LSI jack to the internal error detector. The internal QRSS generator, however, can still furnish a test signal to the span line even though a repeater is not present in the unit. Under these conditions .e error detector can be used by applying a signal to the DET INPUT jack.

3.5 Although the 7007 can be used to a limited degree as explained in the preceeding paragraph, it is recommended that a customer-supplied repeater be permanently installed in the set. The 7007 is designed to accommodate a type 209A/B repeater.

3.6 To install the repeater, perform the following steps.

a. Remove the ac power cord.

b. On the bottom of the set, remove the four screws that secure the repeater access cover.

c. Remove the access cover.

d. Install customer-supplied 209-type repeater in the connector.

e. Replace cover and secure with screws.

3.7 SPAN LINE TEST CORD

3.8 As a safety feature, the 7007 LSO and LSI jacks are arranged to accept a standard dual 310 plug. For all applications, the end of the span line test cord that plugs into the 7007 must be equipped with a dual 310 plug. Do not use a cord longer than 6 feet.

3.9 When powering SLC-40 span lines, both ends of the powering cord must be equipped with dual 310 plugs. Mark both ends to identify the LSO and LSI halves of the plugs.

3.10 When powering T1 span lines from such access points as the MDF or the Office Repeater Bay, it is recommended that a dual 310 jack be temporarily wired to the access points. This will reduce the chances of short circuits caused by clip leads or other such connecting devices. If this is done, a single cord equipped with marked dual 310 plugs at both ends can be used for all applications.

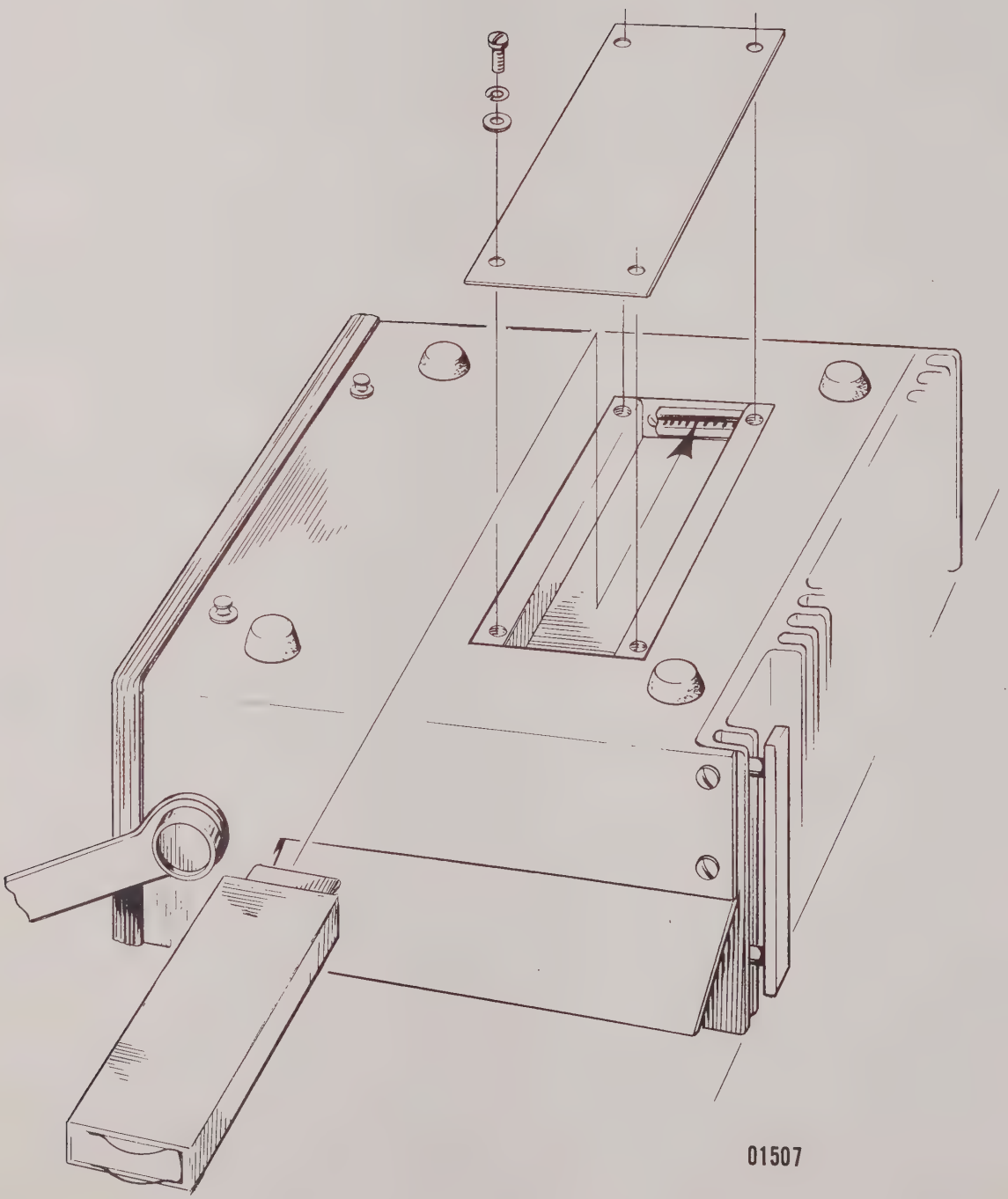

Figure 3—1. Model 7007 Customer-Supplied Repeater Installation

SECTION 4

OPERATION

4.1 INTRODUCTION

4.2 This section contains a table of operating control descriptions and operating instructions for several SLC-40 subscriber carrier and T1 carrier applications. In addition, instructions for adjusting the constant current output are given.

4.3 CONTROLS INDICATORS AND CONNECTORS

4.4 Descriptions of all Model 7007 controls, indicators and connectors are listed in Table 4—1 and shown on Figure 4—1.

Table 4—1. Model 7007 Controls, Indicators and Connectors

REF DESIG	CONTROL, INDICATOR OR CONNECTOR	FUNCTION
DS1	POWER indicator	When lighted, indicates that ac power is applied to unit.
DS2	HIGH VOLTAGE indicator	When lighted, indicates that high voltage power supply has been enabled and that an output current should be present at the LSO and LSI jacks.
DS3	RETURN CURRENT LIMITING indicator	When fully lighted, indicates that return current at LSO jack J6 is being limited to a nominal 165 mA.
DS4, DS5, DS6	PULSES, ERRORS, and OSCILLATION indicators	When only PULSES indicator is lighted, the presence of an error-free PCM signal is indicated. When PULSES and ERRORS indicators are lighted, a PCM signal with bipolar violations is indicated. When PULSES and OSCILLATION indicators are lighted, all ones oscillations are present. When ERRORS and OSCILLATION indicators are lighted, 10 kHz oscillations are present.
F1	1A ac slow blow power fuse (rear panel)	Protection for 117 Vac power source.
F2	.2A fuse (front panel)	Output line current fuse.
J2	QRSS OUTPUT jack	310 type jack that has 1.544 MHz QRSS generator output at full-strength level present at all times.
J3	EXT INPUT jack	Input 310 jack for connecting full-strength level signal. This signal then replaces signal from internal QRSS generator.

Table 4—1. (cont'd)

REF DESIG	CONTROL, INDICATOR OR CONNECTOR	FUNCTION
J4	RPTR OUTPUT jack	310 jack that makes available for external use, the full-strength signal output of the internal 209 repeater. All other internal circuits function in a normal manner.
J5	DET INPUT jack	When a 310 plug is inserted into this connector, internal error detector can be used to examine an external signal. Output from the internal repeater is removed.
J6, J7	LSO (Line Signal Out) and LSI (Line Signal In) jacks	These two connectors must always be used in conjunction with a dual 310 plug. LSO jack J6 connects simplexed power and test signal to a span line. LSI jack J7 is the power return and also connects the signal to the internal repeater. Both jacks are insulated from chassis ground.
M1	Meter	Displays span line voltage and current as controlled by S5.
S1	Interlock switch (under top cover)	Safety feature to remove 117 Vac input power from the 7007 power supply when the top cover is removed.
S2	Thermostat switch (inside heatsink)	Opens to remove the 117 Vac input power from the power supply when the temperature of the rear heat sink reaches +85°C. Closes at +75°C.
S3	POWER switch	When set to ON position, applies 117 Vac power to the unit.
S4	HIGH VOLTAGE START pushbutton switch	When power switch S3 is set to ON, and S5 is set to any position other than OFF and when both dual 310 plugs at the ends of the span line test cord are inserted into their respective jacks, the high voltage power supply is enabled when S4 is depressed.
S5	Meter select switch	When set to the +I and −I positions, the span line current and the return current respectively are measured. When set to the +V and −V positions, the voltage at the LSO jack is measured above ground and below ground respectively. When set to V OUT position, the total span line voltage is measured. When set to OFF, the high voltage power supply is deenergized. This allows the test signal to be applied to the span line with no powering.

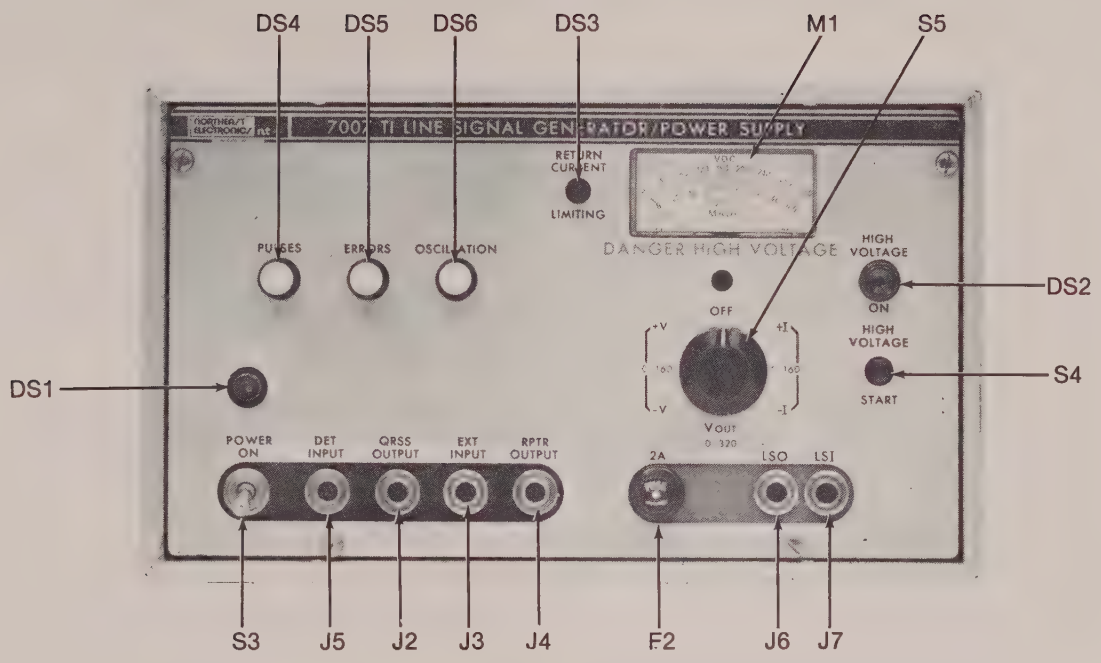

Figure 4—1. Model 7007 Controls, Indicators and Connectors

4.5 POWERING SLC-40 SPAN LINE

4.6 Depending on length, a subscriber carrier span line may have to be powered from the COT (Central Office Terminal) only or from both the COT and the RT (Remote Terminal). See Figures 4—2 and 4—3 for these applications. The power loop resistance, including the resistance contributed by the repeaters, must be within the range of 147 to 1860 ohms at 140 milliamperes. The required constant current is normally set at 140 milliamperes. Refer to paragraph 4.16 for permissible load resistance at other load currents. To power a SLC-40 span line, perform the following steps.

WARNING

When the 7007 high voltage power supply is operating, dangerous high voltages are present in the span line power distribution system.

The 7007 front panel is not dripproof and the cover seams are not waterproof. Do not use the set in the rain, snow or in any other environment where water may drip on it. Failure to comply may result in personal injury and/or damage to the set.

a. The Model 7007 regulating circuits can be damaged by excessive foreign voltages present on the span line. Before connecting the 7007 to the span line, always measure the dc and induced 60 Hz ac voltage to ground on each side of the unpowered span line. If foreign voltages are found to be present on the line, locate and remove the sources before proceeding. Also check for short to earth ground on LSO and LSI jacks.

NOTE

A 60 Hz induced voltage should not exceed 60 Vrms or 60% of V OUT (measured in step k) whichever is less. The high voltage power supply may go out of regulation if an induced 60 Hz voltage exceeds this limit.

b. Ensure that the ac power cord is **not** connected to an ac power source.

c. Connect a test cord, equipped with dual 310 plugs on both ends, to the 7007's LSO and LSI jacks. The maximum allowable cord length is 6 feet.

d. If powering from the COT location, connect other end of the test cord to the COT's LSO and LSI jacks. If powering from the RT location, connect other end of the test cord to the RT's SIDE 1 and SIDE 2 jacks. (If the line must be powered from both locations, two Model 7007's are required.)

e. Connect the 7007's ac power plug to a 117 Vac, 60 Hz power source.

f. Set the POWER switch to the ON position. The POWER indicator should be lighted.

g. Set the meter function switch to any position except OFF.

h. Momentarily depress the HIGH VOLTAGE START pushbutton switch. The HIGH VOLTAGE ON indicator should be lighted.

NOTE

For safety reasons, the 7007 requires that office ground be returned on the sleeve of both the LSO and LSI jacks to enable operation of the high voltage power supply. If the HIGH VOLTAGE ON indicator will not light, check to ensure that the sleeves are properly connected to office ground.

i. Set the meter function switch to +I position. For a normally operating span line, the meter should indicate 140 ± 2.5 milliamperes. A reading of 0 indicates that there is an open somewhere in the span line power loop. A reading of less than 135 milliamperes, in conjunction with a V OUT reading of 270 volts (step k), is an indication that the span line may be too long.

NOTE

When operating continuously into short span lines (less than 400 ohms) at high ambient temperature (+32 to +38°C) the output current will slowly decrease after one to two hours of operation. This is a normal protective feature of the current regulators.

j. Set the meter function switch to the −I position. For a normally operating span line, the meter should indicate 140 ± 2.5 milliamperes. If the +I reading is normal and the −I reading is low, a leakage to ground somewhere on the span line is indicated. A high −I reading indicates that a foreign voltage is present on the span line. Investigate the span line and remove the foreign voltage source before continuing.

k. Set the meter function switch to the V OUT position. Depending on the length of the span line, the top meter scale should read between 21 and 260 volts.

l. If V OUT is 135 volts or greater, set the meter function switch to +V. Depending on the length of the span line, the lower meter scale should now read between 0 and 135 Vdc.

m. If V OUT is less than 135 volts, set the meter function switch to −V. Depending on the length of the span line, the lower meter scale should read between 0 and −135 Vdc.

NOTE

For different span line load resistances, see Figure 4−11 to determine the expected readings for V OUT, +V and −V.

n. The SLC-40 span line is now being powered and supplied an error-free, quasi-random, 1.544 megabit test signal that can be used to troubleshoot intermediate repeaters. The internal error detector and the front panel lamps will show the status of whatever signal happens to be present at the 7007 LSI jack. Refer to paragraph 4.12, step f, for an interpretation of the lighted lamp combinations.

WARNING

The 7007 has a thermostat that opens at +85°C to remove ac power from the set. When the ambient temperature is high and a short span line is being powered, the heatsink temperature may approach +85°C. This may be uncomfortable to the touch.

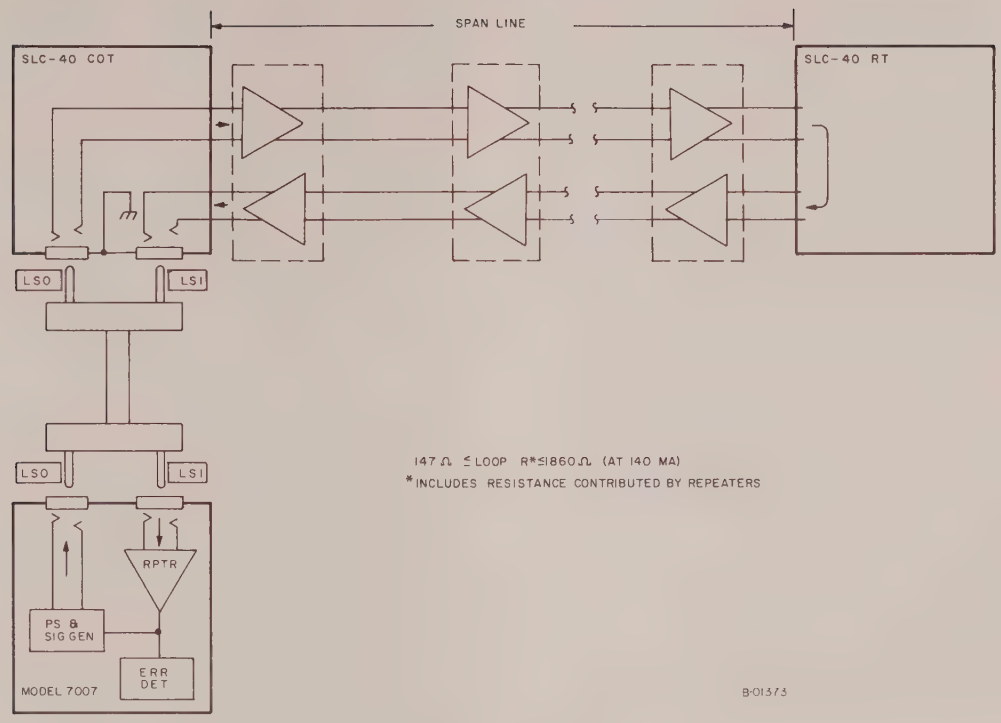

Figure 4—2. Powering SLC-40 Span Line From The COT

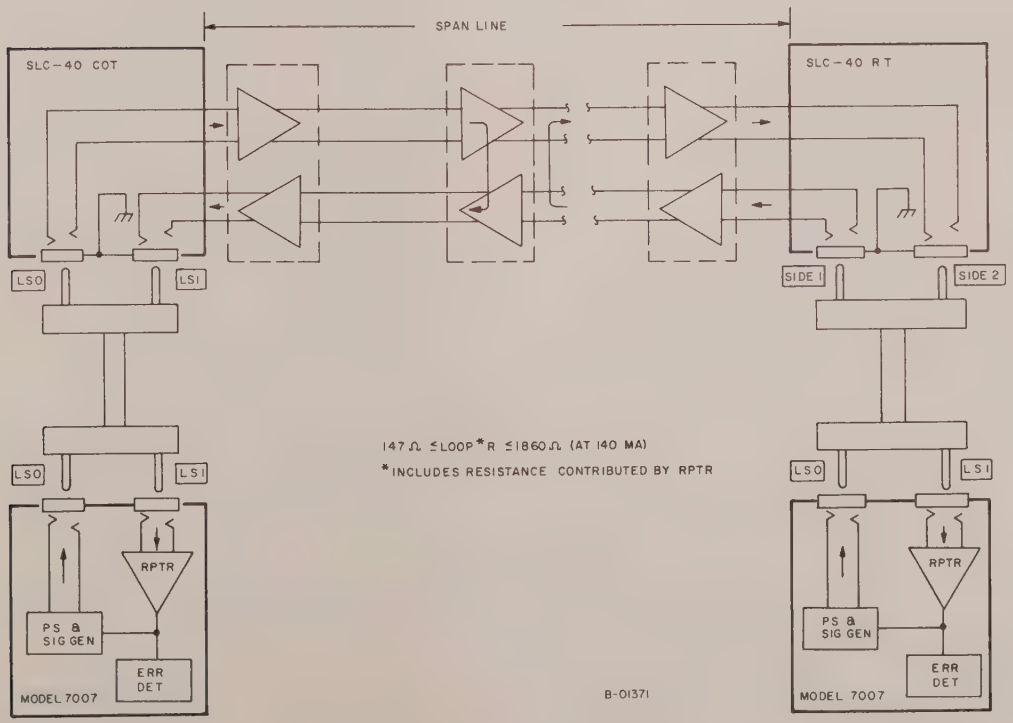

Figure 4—3. Powering SLC-40 Span Line From The COT and RT

4.7 LOOPING SIGNAL AT THE SLC-40 RT.

4.8 Figure 4—4 shows an application where the 7007 can be used to loop back to the COT a signal being received at the RT. Since the internal, customer-supplied repeater is used in this configuration, the high voltage power supply must be operating to power the repeater. This application can only be used when the 7007 is powering the span line from the RT. A portion of the span line can also be simultaneously powered from the COT. To loop back at the RT, perform the following steps.

WARNING

When the 7007 high voltage power supply is operating, dangerous high voltages are present in the span line power distribution system.

The 7007 front panel is not dripproof and the cover seams are not waterproof. Do not use the set in the rain, snow or in any other environment where water may drip on it. Failure to comply may result in personal injury and/or damage to the set.

a. The Model 7007 regulating circuits can be damaged by excessive foreign voltages present on a span line. Before connecting the 7007 to a span line, always measure the dc and induced 60 Hz ac voltage to ground on each side of the unpowered span line. If foreign voltages are found to be present on the line, locate and remove the sources before proceeding. Also check for short to earth ground on LSO and LSI jacks.

NOTE

A 60 Hz induced voltage should not exceed 60 Vrms or 60% of V OUT (measured in step l) whichever is less. The high voltage power supply may go out of regulation if an induced 60 Hz voltage exceeds this limit.

b. Ensure that the ac power cord is **not** connected to an ac power source.

c. Connect a test cord, equipped with dual 310 plugs on both ends, to the 7007 LSO and LSI jacks. The maximum cord length is 6 feet.

d. Connect the other end of the test cord to the SIDE 1 and SIDE 2 jacks at the RT.

e. On the 7007, connect a short test cord equipped with 310 plugs between the RPTR OUTPUT and EXT INPUT jacks.

f. Connect the 7007's ac power plug to a 117 Vac, 60 Hz power source.

g. Set the POWER switch to the ON position. The POWER indicator should be lighted.

h. Set the meter function switch to any position except OFF.

i. Momentarily depress the HIGH VOLTAGE START pushbutton switch. The HIGH VOLTAGE ON indicator should be lighted.

NOTE

For safety reasons, the 7007 requires that office ground be returned on the sleeve of both the LSO and LSI jacks to enable operation of the high voltage power supply. If the HIGH VOLTAGE ON indicator will not light, check to ensure that the sleeves are properly connected to office ground.

j. Set the meter function switch to the +I position. For a normally operating span line, the meter should indicate 140 ± 2.5 milliamperes. A reading of 0 indicates that there is an open somewhere on the span line. A reading of less than 135 milliamperes, in conjunction with a V OUT reading of 270 volts (step l), is an indication that the span line may be too long.

NOTE

When operating continuously into short span lines (less than 400 ohms) at high ambient temperature (+32 to +38°C) the output current will slowly decrease after one to two hours of operation. This is a normal protective feature of the current regulators.

k. Set the meter function switch to the −I position. For a normally operating span line, the meter should indicate 140 ± 2.5 milliamperes. If the +I reading is normal and the −I reading is low, a leakage to ground somewhere on the span line is indicated. A high +I reading indicates that a foreign voltage is present on the span line. Investigate the span line and remove the foreign voltage source before continuing.

l. Set the meter function switch to the V OUT position. Depending on the length of the span line, the meter scale should read between 20 and 260 volts.

m. If V OUT is 135 volts or greater, set the meter function switch to +V. Depending on the length of the line, the lower meter scale should now read between 0 and +135 Vdc.

n. If V OUT is less than 135 volts, set the meter function switch to −V. Depending on the length of the line, the lower meter scale should now read between 0 and −135 Vdc.

NOTE

For different span line load resistances, see Figure 4−11 to determine the expected readings for V OUT, +V and −V.

o. The span line (or a portion of it) is now being powered from the RT and any test signal applied at the COT is being loop by the 7007 and returned to the COT. In this manner, both sides of all span line repeaters can be tested without need for a signal source at both ends of the line.

WARNING

The 7007 has a thermostat that opens at +85°C to remove ac power from the set. When the span line is being powered, the heatsink temperature may approach +85°C. This may be uncomfortable to the touch.

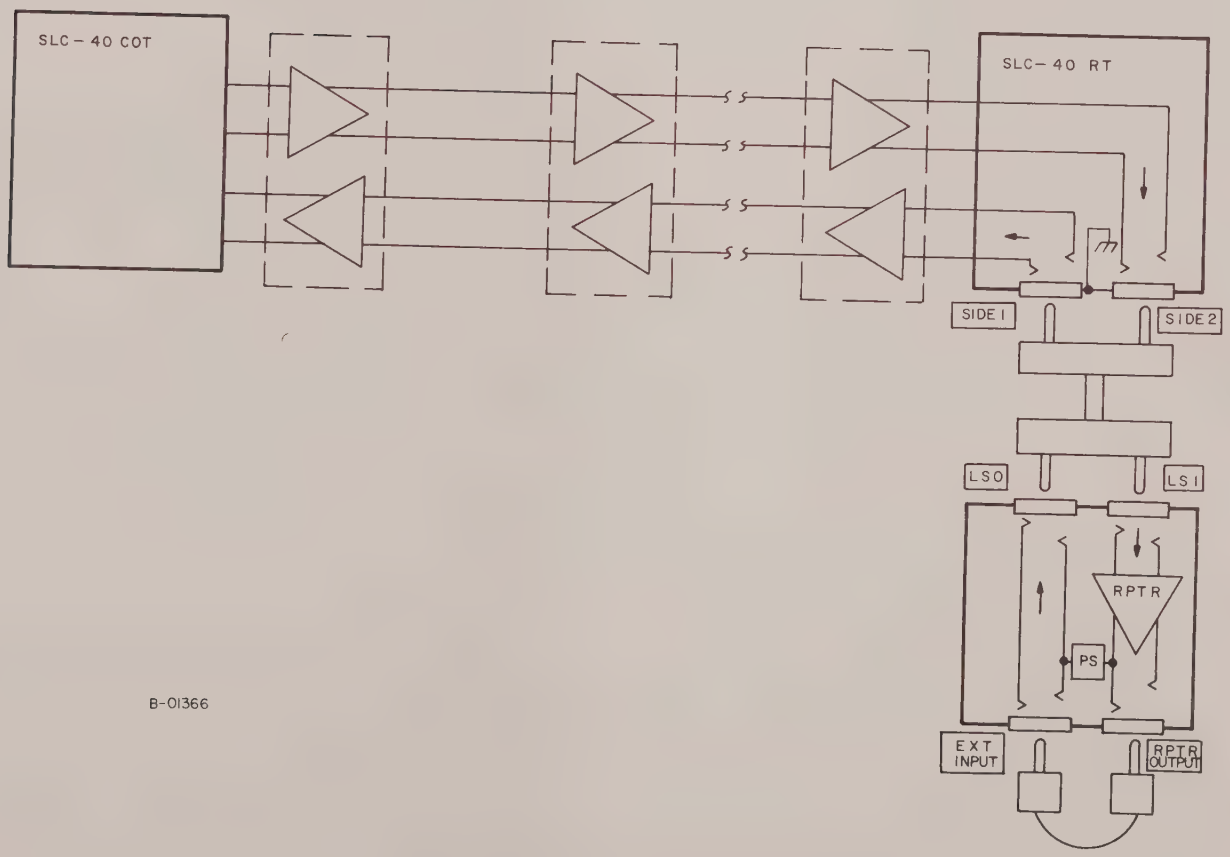

Figure 4−4. Using the 7007 at SLC-40 RT To Loop Signal Back To COT

4.9 7007 AS A REPLACEMENT FOR TYPE 206 OFFICE REPEATER

4.10 The 7007 provides the three essential office repeater functions of: (1) span line power, (2) signal generation, and (3) signal regeneration on the return line. As such, the set can be used as a replacement for a type 206 or equivalent T1 office repeater. In this application, the span line must be unpowered, i.e., the office repeater removed, before the 7007 can be used. Figures 4—5 and 4—6 show typical applications of the 7007 used in place of an office repeater. Connection to the span line can be made at convenient places such as the Office Repeater Bay or the MDF. As shown on the application drawings, the 7007 can be used to power a T1 span line and apply a test signal. The 7007 can also be used with a regular T1 Fault Locator and Signal Generator to make span line fault locating tests. To use the 7007 as a substitute office repeater, perform the following steps.

WARNING

When the 7007 high voltage power supply is operating, dangerous high voltages are present in the span line power distribution system.

a. The Model 7007 regulating circuits can be damaged by excessive foreign voltages present on a span line. Before connecting the 7007 to a span line, always measure the dc and induced 60 Hz ac voltage to ground on each side of the unpowered span line. If foreign voltages are found to be present on the line, locate and remove the sources before proceeding. Also check for short to earth ground at LSO and LSI jacks.

NOTE

A 60 Hz induced voltage should not exceed 60 Vrms or 60% of V OUT (measured in step m) whichever is less. The high voltage power supply may go out of regulation if an induced 60 Hz voltage exceeds this limit.

b. Ensure that the ac power cord is **not** connected to an ac power source.

c. At the T1 span line appearance to be used, temporarily wire a dual 310 jack as shown on Figures 4—5 and 4—6. The sleeves of both jacks must be connected to office ground. Label side 1 as LSO and side 2 as LSI.

d. Connect the test cord, equipped with dual 310 plugs on both ends, to the 7007 LSO and LSI jacks. Maximum allowable cord length is 6 feet.

e. Connect the other end of the test cord to the temporary LSO and LSI jacks installed in step c.

f. If a T1 Fault Locator and Signal Generator is used connect the signal generator output to the 7007 EXT INPUT jack. The T1 fault locating signal will be applied to the span line through the 7007 high voltage power supply.

g. Connect the 7007's ac power plug to a 117 Vac, 60 Hz power source.

h. Set the POWER switch to the ON position. The POWER indicator should be lighed.

i. Set the meter function switch to any position except OFF.

j. Momentarily depress the HIGH VOLTAGE START pushbutton switch. The HIGH VOLTAGE ON indicator should be lighted.

NOTE

For safety reasons, the 7007 requires that office ground be returned on the sleeve of both the LSO and LSI jacks to enable operation of the high voltage power supply. If the HIGH VOLTAGE ON indicator will not light, check to ensure that the sleeves are properly connected to office ground.

k. Set the meter function switch to the +I position. For a normally operating span line, the meter should indicate 140 ± 2.5 milliamperes. A reading of 0 indicates that there is an open somewhere in the span line powering loop. A reading of less that 135 milliamperes, in conjunction with a V OUT reading of 270 volts (step m), is an indication that the span line may be too long.

NOTE

When operating continuously into short span lines (less than 400 ohms) at high ambient temperature (+32 to +38°C) the output current will slowly decrease after one to two hours of operation. This is a normal protective feature of the current regulators.

l. Set the meter function switch to the −I position. For a normally operating span line, the meter should indicate 140 ± 2.5 milliamperes. If the +I reading is normal and the −I reading is low, a leakage to ground somewhere on the span line is indicated. A high −I reading indicates that a foreign voltage is present on the span line. Investigate the span line and remove the foreign voltage source before continuing.

m. Set the meter function switch to the V OUT position. Depending on the length of the span line, the top meter scale should read between 20 and 260 volts.

n. If V OUT is 135 volts or greater, set the meter function switch to +V. Depending on the length of the line, the lower meter scale should now read between 0 and +135 Vdc.

o. If V OUT is less than 135 volts, set the meter function switch to −V. Depending on the length of the line, the lower meter scale should now read between 0 and −135 Vdc.

NOTE

For different span line load resistances, see Figure 4−11 to determine the expected readings for V OUT, +V and −V.

p. The 7007 is now powering a T1 span line and routing a T1 fault locating signal into the span line, if the T1 Fault Locator and Signal Generator is in use. The 7007's internal error detector and front panel indicator lamps will provide visual indication of the status of whatever signal is being received on side 2.

WARNING

The 7007 has a thermostat that operates at +85°C to remove ac power from the set. When the ambient temperature is high and a short span line is being powered, the heatsink temperature may approach +85°C. This may be uncomfortable to the touch.

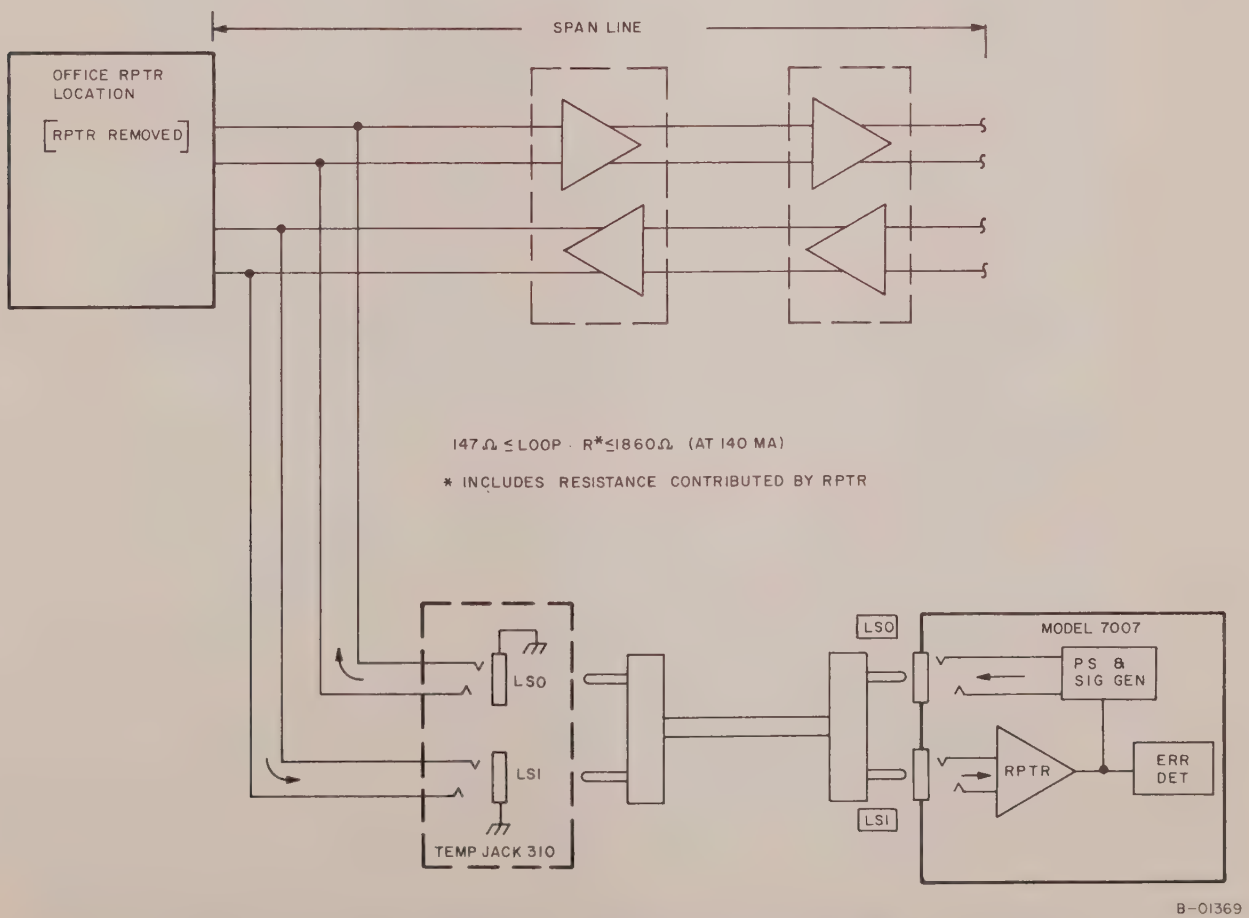

Figure 4−5. Using The 7007 As A Replacement For Type 206 (Or Equivalent) Office Repeater To Power A T1 Span Line

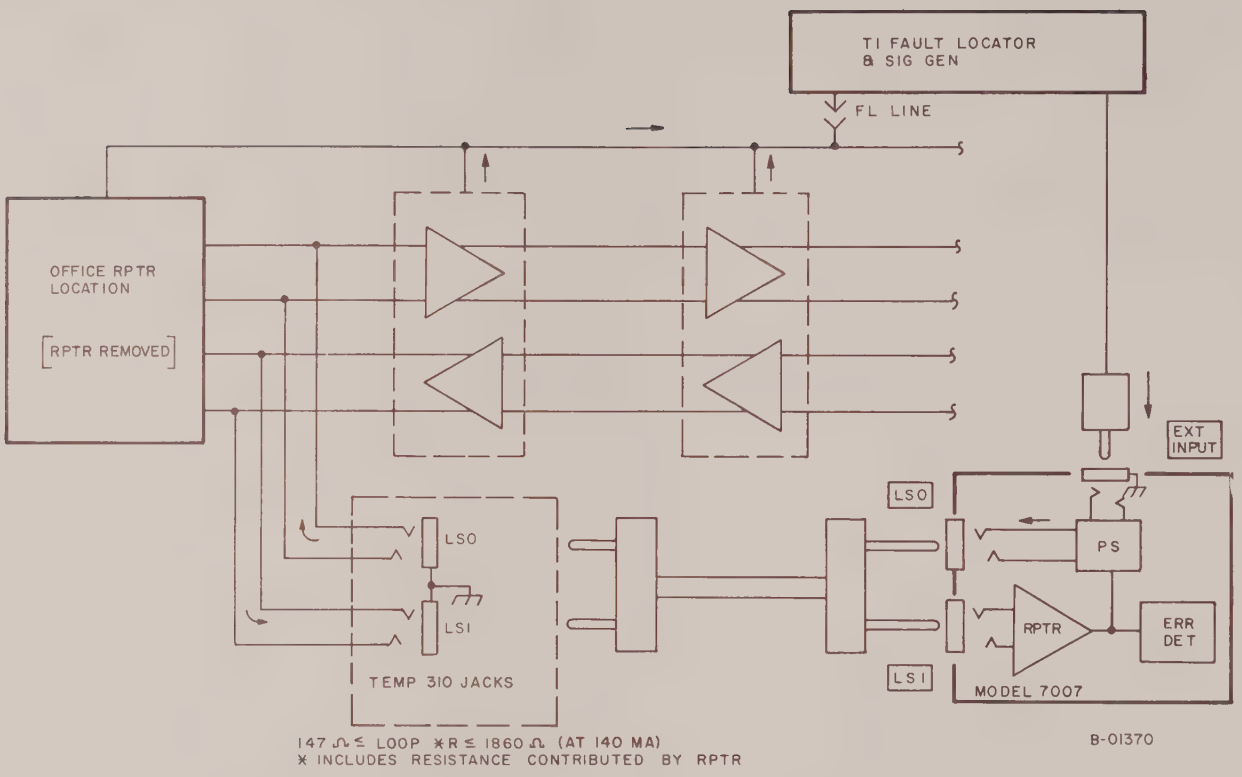

Figure 4—6. Using the 7007 As A Replacement For Type 206 (Or Equivalent) Office Repeater To Power And Apply FL Signal To A T1 Span Line

4.11 7007 AS A T1 OFFICE ERROR DETECTOR

4.12 As shown on Figure 4—7, the internal error detector in the 7007 can be utilized as a T1 office error detector without powering the span line. Test access to a span line is gained through either MON jack located on the front panel of the office repeater. To use the 7007 as an error detector, perform the following steps.

a. Connect a test cord between the 7007 DET INPUT jack and either MON jack on the front of the office repeater associated with the span line to be tested.

b. Set 7007's meter function switch to OFF. This inhibits the high voltage power supply.

c. Connect the 7007's ac power plug to a 117 Vac, 60 Hz source.

d. Set the POWER switch to the ON position. The POWER indicator should be lighted.

e. Observe the ERRORS, PULSES and OSCILLATION lamps.

f. Status of the line signal can be determined from the lighted lamp status as shown below.

Lamps Lighted	Indicates
PULSES:	error-free signal
PULSES + ERRORS:	signal with bipolar violations
PULSES + OSCILLATION:	all ones oscillation
ERRORS + OSCILLATION:	10 kHz oscillation

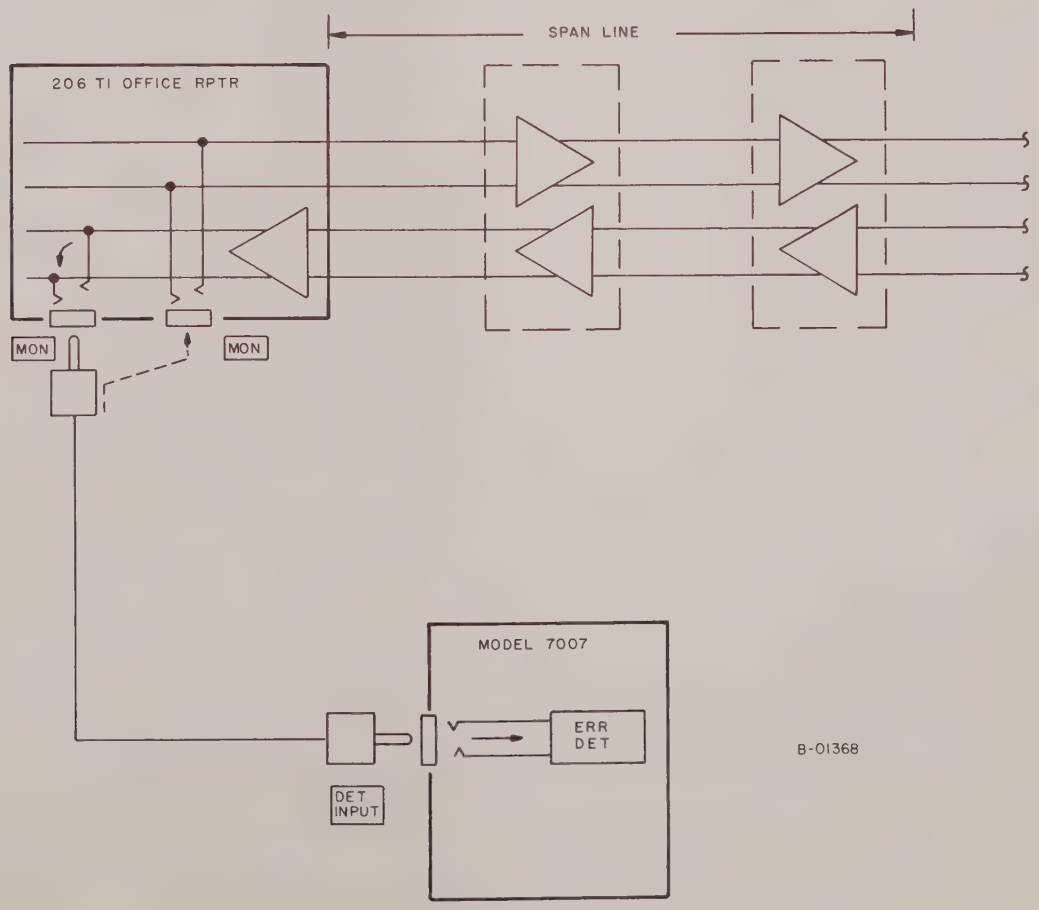

Figure 4—7. Model 7007 Used As A T1 Office Error Detector

4.13 7007 AS A T1 LINE SIGNAL GENERATOR

4.14 The internal signal generator of the 7007 can be used to supply an error-free test signal to a T1 span line. Normal access to the line will be at the L IN jack on the front of the office repeater. No power is applied to the span line in this mode. To apply a signal to a T1 line, shown on Figure 4—8, perform the following steps.

a. Connect a test cord between the 7007's QRSS OUTPUT jack and the L IN jack on the front panel of the office repeater associated with the T1 span line to be tested.

b. Set the 7007's meter function switch to OFF. This inhibits the high voltage power supply.

c. Connect the 7007's power plug to a 117 Vac, 60 Hz source.

d. Set the POWER switch to ON. The POWER indicator should be lighted.

e. The Model 7007 is now furnishing an error-free quasi-random test signal at 1.544 Megabits per second. The signal level is 3 volts ground-to-peak.

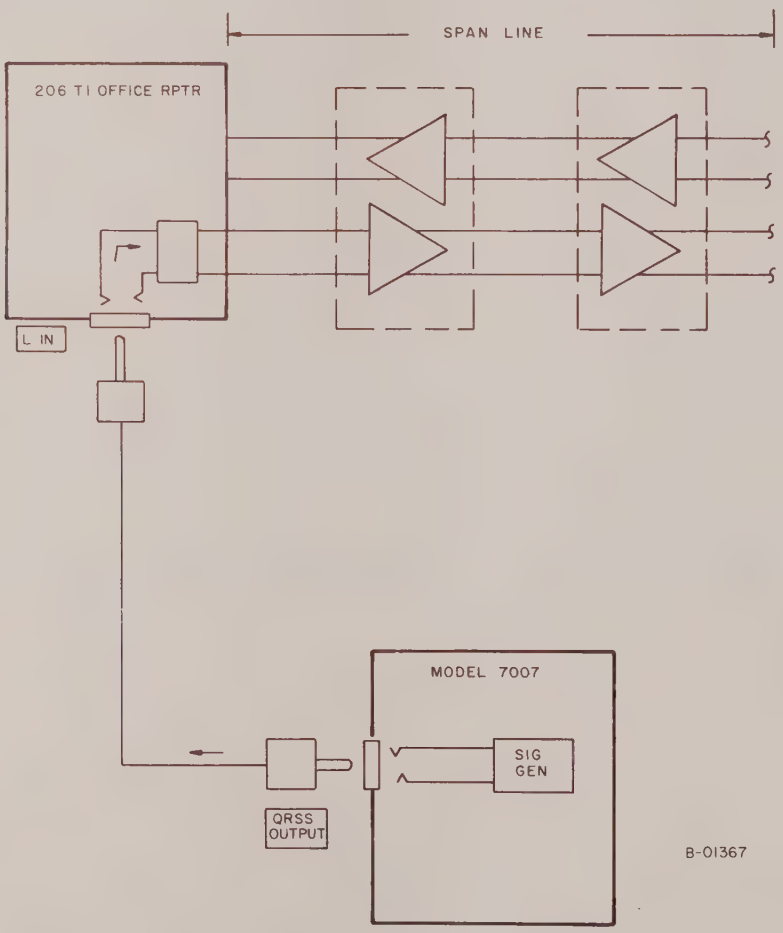

Figure 4—8. Using The 7007 As A T1 Span Line Signal Generator

4.15 OUTPUT CURRENT ADJUSTMENT

4.16 Although the T1 and SLC-40 repeaters currently in use operate at a nominal 140 milliamperes, there are some low-current repeaters in use. A calibration adjustment allows the current to be set within the range of 50 to 160 milliamperes. The maximum output remains at 260 Vdc.This allows load resistances within the range of 125 to 5200 ohms. To adjust the output current, perform the following steps.

a. Construct a dummy load as shown in Figure 4—9.

b. Ensure that the 7007's ac power plug is **not** connected to an ac power source.

WARNING

When the 7007 high voltage power supply is operating, dangerous high voltages are present in the unit.

c. Remove the adjustment access cap located on the top cover. (See Figure 4—10.)

d. Connect a test cord between the dummy load and the 7007's LSO and LSI jacks.

e. Connect the dummy load sleeve clip lead to the 7007 chassis. This ensures that the high voltage power supply is enabled for operation.

f. Connect the 7007's ac power plug to a 117 Vac, 60 Hz power source.

g. Set the POWER switch to the ON position. The POWER ON indicator should be lighted.

h. Set the 7007's meter function switch to the +I position.

i. Momentarily depress the HIGH VOLTAGE START pushbutton. The HIGH VOLTAGE ON indicator should be lighted.

j. The meter should indicate 140 ± 2.5 milliamperes or whatever current the supply was last set to.

k. Using a small insulated screwdriver or alignment tool, adjust the output current (within the range of 50 to 160 milliamperes) to the desired value, as shown on the front panel meter.

NOTE

Above 140 milliamperes, the RETURN CURRENT LIMITING lamp will be partially turned on. This may not be noticable in high ambient light conditions.

l. Set the POWER switch to the down position.

m. Replace the adjustment access cap.

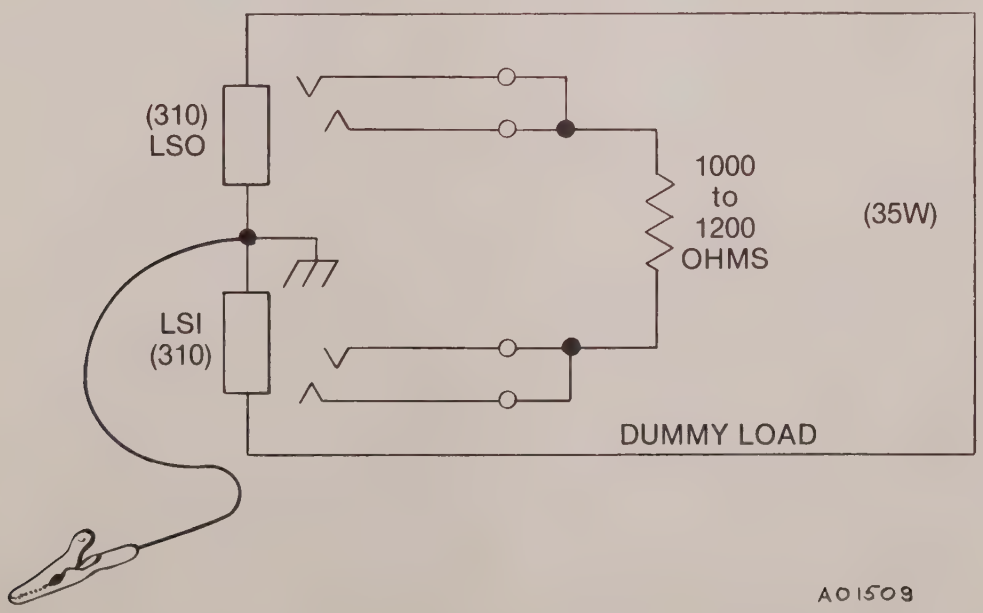

Figure 4—9. Dummy Load Box For Testing And Adjusting The Model 7007

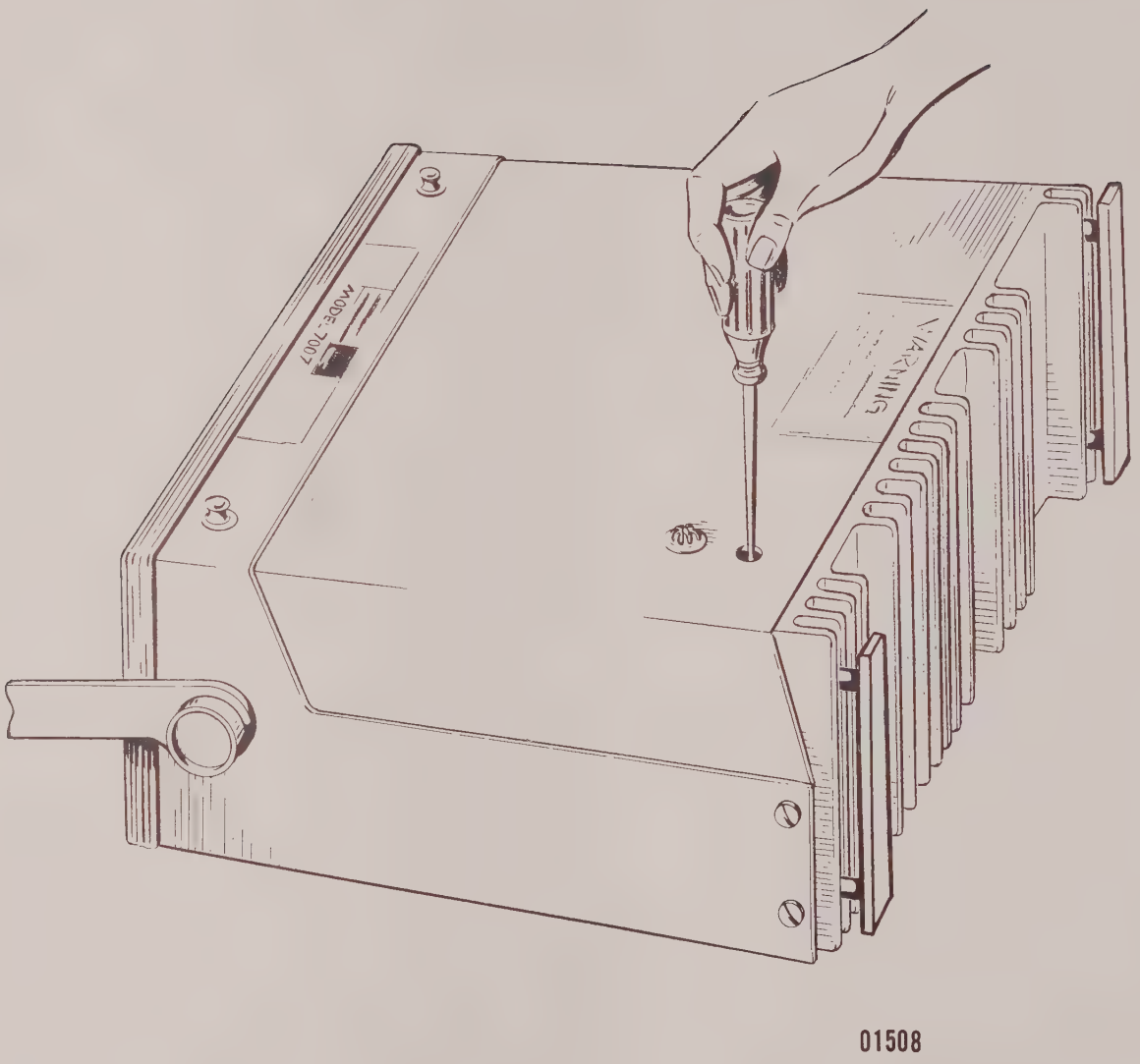

Figure 4—10. Model 7007 Output Current Adjustment Location

4.17 USING THE CHART ON FIGURE 4—11

4.18 Figure 4—11 is a plot of load resistance (usually the known) against V OUT (the voltage across the load resistance) and also V LSO (the voltage measured from the LSO jack to ground). It can be used to determine the expected voltages for a given load. The chart is good for a load current of 140 milliamperes. To use the chart, enter the R_L abscissa at the known load resistance and continue vertically until intercepting the diagonal line. Proceed horizontally to the right and read V OUT off of the right ordinate. Follow the same horizontal path to the left ordinate to read V_{LSO}.

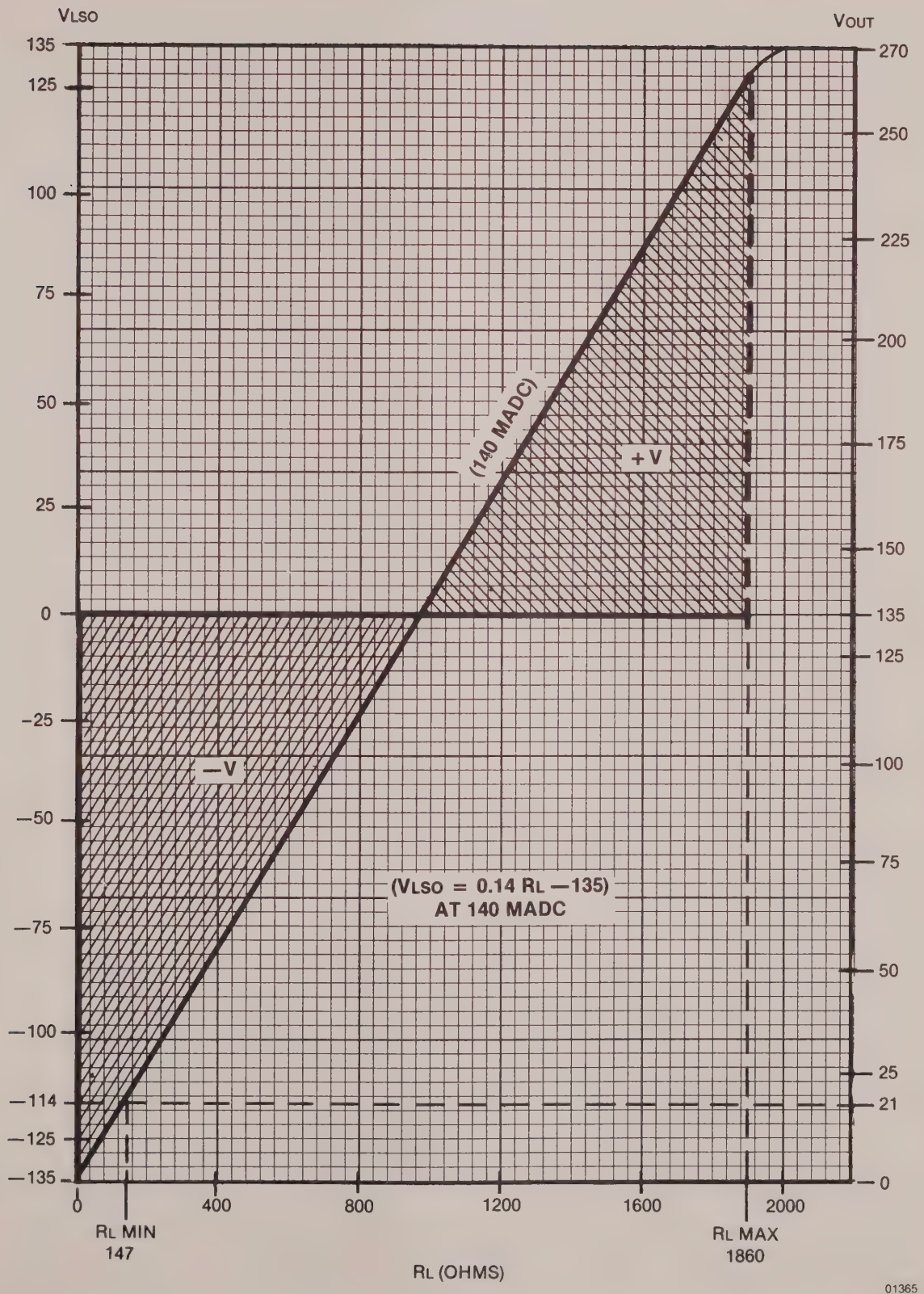

Figure 4—11. Model 7007 Output Voltages vs. Load Resistance At 140 Milliamperes

SECTION 5

CIRCUIT DESCRIPTION

5.1 INTRODUCTION

5.2 This section contains the block diagram and the detailed circuit descriptions for the Model 7007.

5.3 BLOCK DIAGRAM DESCRIPTION

5.4 As shown on Figure 5—1, the Model 7007 consists principally of (1) a constant-current generator that supplies the span line operating current; (2) a QRSS generator that furnishes a 1.544 megabit per second T1 format signal; (3) an error detector to detect the presence of pulses, bipolar violations, all ones and 10-kHz oscillations.

5.5 The high-voltage power supply is the source of span line current furnished by the constant current generator. Span line current is normally 140 milliamperes but can be set to any level within the range of 50 to 160 milliamperes.

5.6 The QRSS (Quasi-Random Signal Source) generator supplies a T1, bipolar signal at 1.544 megabits per second. This output is superimposed upon the span line current. A second generator output is available for external use at the QRSS OUTPUT jack. If desired, an external signal source can be used by application to the EXT INPUT jack through a set of transfer contacts.

5.7 A customer-supplied 209-type repeater is required to complete the span line current and the QRSS signal paths into the unit. The repeater also ensures that a full-strength signal is made available to the error detectors. This same repeater output signal is available for external use at the RPTR OUTPUT jack.

5.8 Detection of normal T1 pulses, bipolar violations, all ones oscillations, and 10 kHz oscillations is the function of the error detectors. Combinations of front-panel indicator lamps give the correct error interpretations. The DET INPUT jack allows the error detectors to be used for analyzing an external signal.

5.9 Span line design specificaitons require that the LSO voltage be clamped at −135 volts with respect to chassis ground. This is accomplished by applying the high-voltage power supply output across a zener diode regulator connected between the LSO output jack and ground.

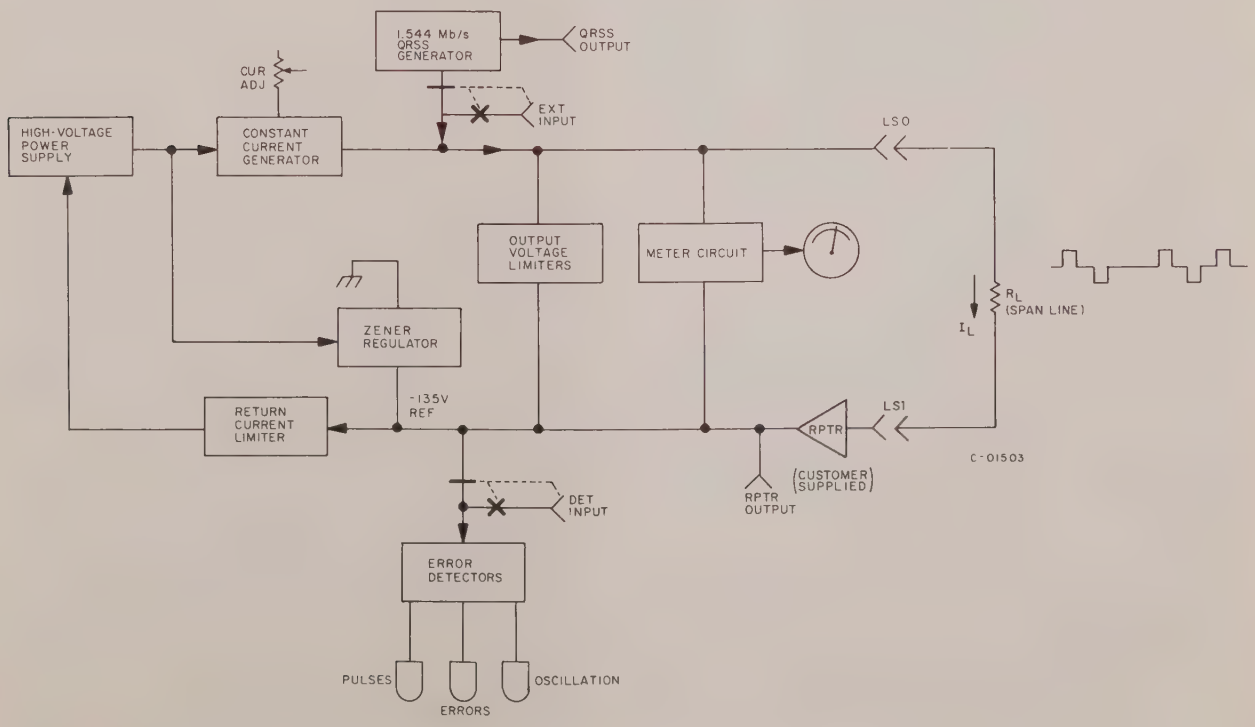

Figure 5—1. Model 7007 Functional Block Diagram

5.10 Although the current applied to the span line through the LSO jack is well regulated, the presence of a foreign voltage on the span line can result in a very large return current. A return current limiter keeps this current within safe limits.

5.11 To protect against failure of the constant current generator, a crowbar circuit monitors the output voltage and fires when the output voltage exceeds 300 Vdc.

5.12 Metering circuits and appropriate switching functions allow the unit to monitor the current being supplied by the LSO jack, the current being received by the LSI jack, the voltage present at the LSO jack, and the total voltage across the LSO and LSI jacks.

5.13 QRSS GENERATOR CIRCUIT BOARD (A6A3) DESCRIPTION

5.14 Figure 7—1 shows the QRSS generator circuit board in a functional form. See Figure 7—9 for the complete schematic diagram of the board. As shown on Figure 7—1, the board consists of: (1) a clock source, (2) a QRSS generator, (3) a preset enable and sync pulse generator, (4) a 15 zeros suppressor, and (5) a unipolar-to-bipolar converter/driver.

5.15 CLOCK SOURCE

5.16 NOR gates U1C and U1D are cross-coupled through capacitors C1 and C2 to form an astable multivibrator. Crystal Y1 is resonant at 1.544 MHz and determines the astable operating frequency. Schmitt trigger U1A-U1B generates the fast transition times required by the logic gates that follow. The clock waveform appearing at E1-E2 is a symmetrical squarewave at the basic clock frequency. Inverter U11C provides an inverted clock waveform for use in clocking the unipolar-to-bipolar converter/driver.

5.17 QRSS GENERATOR

5.18 The function of the QRSS (Quasi-Random Signal Source) is to generate a bit stream of ones and zeros that occur in a pattern long enough to appear to be quasi-random in nature. Use of a 20-bit shift register and feedback decoding of bits 17 and 20 results in a pattern that repeats in frames of 1,048,575 bits at a basic rate of 1.544 megabits per second.

5.19 At the time power is first applied to shift registers U2 through U5, the logic state of all 20 output bits is indeterminate. After a number of clock pulses, however, the output bits will soon reach the state where bits 1 through 19 are low and bit 20 is high. This condition is decoded by Exclusive OR gate U6A, which then applies a high level to the serial input of the shift register. The next positive transition of the clock pulse then causes bit 1 to be high and bits 2 through 20 to be low. Shifting of the serial input occurs until this condition again appears 1,048,575 bits later and the cycle repeats. Bit 20 is used as the QRSS output and is applied to the unipolar-to-bipolar converter/driver, which is discussed in paragraph 5.28.

5.20 PRESET ENABLE AND SYNC PULSE GENERATOR

5.21 The preset enable function is in reality a 20 zeros suppression circuit implemented by the A and B portions of logic gates U6 through U11. If all 20 shift register output bits were to assume the low state simultaneously, the serial input to the register is also at a low level. This condition does not occur during normal operation but could happen if all 20 bits should come up in the low state when power is applied.

5.22 When bits 2 through 5 are low, the output of U7B is high and applied to one input of U10A. When bits 6 through 20 are low, all of the inputs to U10B are high and its low output is inverted to a high level by U11A. Thus if bits 2 through 20 are all low, all four inputs to U10A are high and its output goes low. This is applied to U7A along with bit 1, which is also assumed to be low. The next time the clock pulse goes low, all four inputs to U7A will be low and its output goes high for one half of a clock pulse. This high level is applied to the preset enable input of each shift register. Since all five preset inputs of each shift register are strapped to +5 volts (high), the preset enable pulse loads 20 high levels into the shift registers and normal operation is restored.

5.23 Bits 2 through 20 all go low at the same time only once per data frame. This condition thus forms a convenient point in the frame to generate a sync pulse, which, due to the quasi-random nature of the output, is necessary to observe a steady pulse train on an oscilloscope. When bits 2 through 20 are low, the low output of U10A is inverted by U11B so that the sync pulse is high for one complete clock cycle once per data frame.

5.24 15 ZEROS SUPPRESSION

5.25 One of the specifications for a QRSS bit stream used on a T1 span line is that there be no more than 14 successive zeros. The suppression of more than 14 zeros is the function of U8A/B, U9A/B, U10B, U11A, and U6B.

5.26 Whenever the output of Exclusive OR gate U6B is high, a one is generated in the output bit stream. Most of the time during a data frame, at least one of

the shift register output bits 6 through 19 is high at any given time. This forces the output of U11A to be low thus allowing the output of U6B to follow the state of bit 20, which is the other input of U6B. In this manner, the quasi-random pattern of ones and zeros normally inherent in bit 20 is generated in the bit stream. At other times, however, bits 6 through 20 (or even bits 2 through 20) can all be low at the same time. Assuming the worst case where bits 2 through 20 are low and bit 1 is high, it would normally take 19 clock pulses for the high bit 1 to shift to bit 20 and generate a one in the output bit stream. All of the intervening 19 time slots would result in zeros in the bit stream . . . clearly a violation of the specification. To prevent this condition, ones are stuffed into the bit stream so that only 14 zeros in succession occur. This is accomplished in the following manner.

5.27 With bits 2 through 20 low and bit 1 high, the output of U11A is high and will remain so for five clock pulses until the high of bit 1 is shifted to bit 6. During these five time slots the output of Exclusive OR gate U6B remains high and stuffs five ones into the bit stream. The generation of output bits is described in paragraph 5.28. During the next 14 clock pulses, when the high level is shifted from bit 6 to bit 19, both inputs to U6B are low. This generates 14 successive zeros in the bit stream. When this high level reaches bit 20, the output of U6B is high regardless of the present state of bits 6 through 19 and a one is again injected into the bit stream. Thus no more than 14 successive zeros can occur.

5.28 UNIPOLAR-TO-BIPOLAR CONVERTER/DRIVERS

5.29 An additional specification for a QRSS output on a T1 span line is that successive ones be of opposite polarity regardless of intervening zeros. This is the function of U6B, U12B, the A and B portions of U13 through U15, and output pulse transformers T1A and T1B. Only the output stage associated with T1B will be discussed as the other is identical.

5.30 As long as the output of U6B is low, at least one input to both U13A and U13B is low. This results in high outputs at both of these gates. At this time, the two inputs of both U14A and U14B are high, and their outputs are high. With both ends of T1B at a high level and its center tap tied to +5 volts, no current flows in either the primary or secondary of the transformer. This condition defines a zero bit. It should also be noted that since both the J and K inputs to U12B are low, the flip-flop is not effected by $\overline{\text{CLOCK}}$.

5.31 When both the J and K inputs of U12B are high the flip-flop will change state each time that $\overline{\text{CLOCK}}$ goes negative. As a starting point, assume that Q is high and $\overline{Q}$ is low. The next time that the clock pulse goes high, all three inputs of U13A are high to force its output low. The output of U13B is held low by the low $\overline{Q}$ output of U12B. Under these conditions, the output of U14A is low and the output of U14B high. This results in current flow through the top half of T1B and causes a one to appear in the bit stream. The actual polarity of the one bit in the secondary of the pulse transformer is unimportant. Now assume that at some time later, after any number of intervening zeros, the output of U6B is again high. The Q and $\overline{Q}$ outputs of U12B are now reversed since the negative clock transsition that occurred during the time the last one was generated caused the flip-flop to change state. The next time that the clock goes high, the end result is that current flows in the bottom half of T1B and a one of the opposite polarity is generated.

5.32 ERROR DETECTOR CIRCUIT BOARD (A6A4) DESCRIPTION

5.33 Figure 7—2 shows the error detector board in a functional form. See Figure 7—11 for the complete schematic diagram of the board. As shown on Figure 7—2, the board is comprised of: (1) a pulse shaper and bipolar-to-unipolar circuit, (2) a bipolar violation detector, (3) all ones and 10 kHz oscillation detectors, (4) decoding logic, and (5) lamp driver and timing circuits.

5.34 PULSE SHAPER AND BIPOLAR-TO-UNIPOLAR CONVERTER

5.35 The bipolar bit stream is applied to the primary of pulse transformer T1, which presents a balanced load. Diode CR1, R3, and C2 provide an approximate 0.3-volt forward bias to Q1 and Q2 through the secondary of T1. The bipolar signal riding on this bias alternately causes Q1 and then Q2 to conduct as the bias level is exceeded. These transistors convert the bipolar signal level to one that is compatible with the logic gates that follow. NOR gates U1A and U1B function as inverters and generate the rapid transition times required. As shown on Figure 5—2, the outputs of U1A and U1B each represent a stream of alternate ones, that when taken together, represent all of the interleaved ones.

5.36 The two inputs of U1C are the uncombined ones data provided by U1A and U1B so that the output of U4B is a series of positive, combined pulses totaling the sum of all ones in the bipolar data stream.

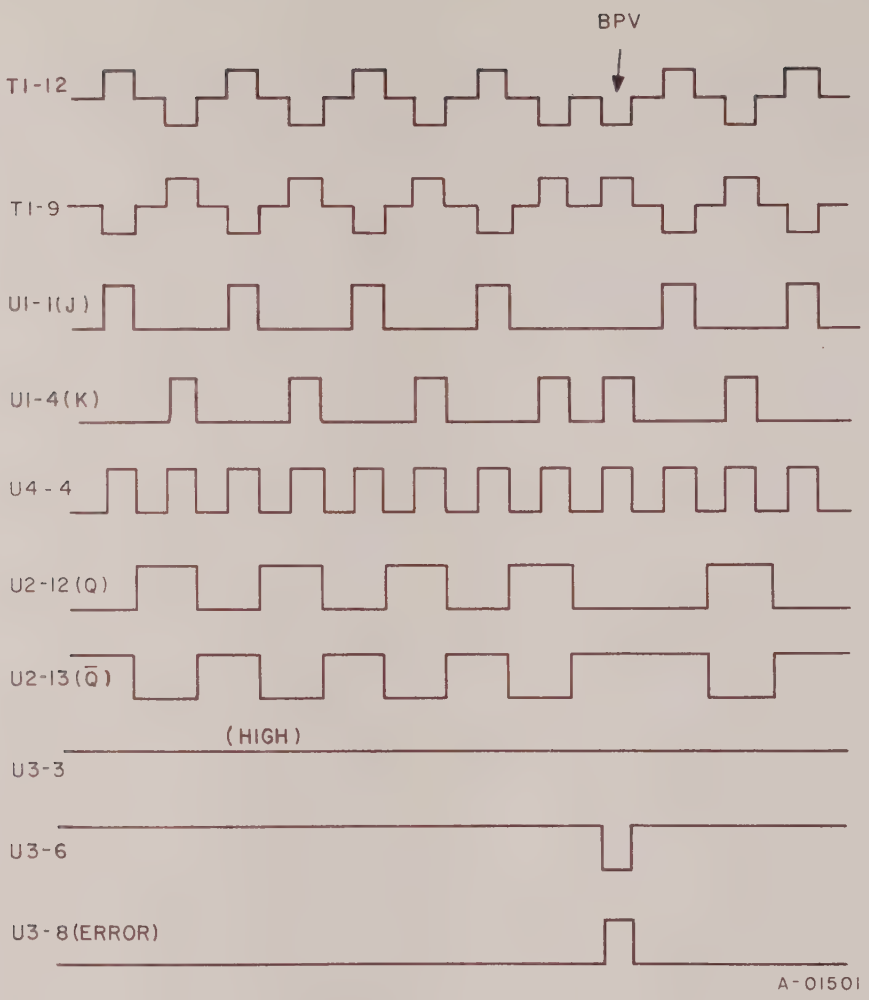

Figure 5—2. Bipolar-To-Unipolar Converter And Bipolar Violation Detector Timing Diagram

5.37 BIPOLAR VIOLATION DETECTOR

5.38 A bipolar violation occurs when adjacent ones in a bit stream are of the same polarity. Detection of bipolar violations is implemented by J-K flip-flop U2A, U3A, U3B, and U3C. For an error-free input signal, the timing of the J and K inputs to U2A and the combined pulses is such that the two inputs to either U3A or U3B are never both high at the same time. This keeps both inputs to U3C always high with the result that its output is always low. As shown on Figure 5—2, the presence of a bipolar violation disrupts the timing by deleting one pulse from either the J or K input to the flip-flop and by adding an extra pulse to the other input. This means that when the clock pulse goes low, the J and K inputs are of such a polarity that the flip-flop does not change state. Now both inputs to either U3A or U3B are high to force its output low. This causes the output of U3C to generate a positive pulse for each bipolar violation detected.

5.39 ALL ONES DETECTOR

5.40 The function of the all ones detector is to differentiate between a normal T1 bit stream containing random zeros and a stream of all ones. The detector is comprised of voltage comparators U6D and U6B and RC time constants R7-C4 and R9-C7.

5.41 As shown on Figure 5—3, the output of U4A is low during a one bit, high for 0.97 microsecond between adjacent ones, and high for 1.62 microseconds during an intervening zero. Voltage comparator U6D, along with RC network R7-C4, functions as a timer that distinguishes between these two time periods. The low output of U4A always discharges C4, which then charges during the time that the output of U4A is high. It is seen that whenever a zero is present, C4 charges long enough to exceed the reference voltage set by R12 and R13. This causes the output of U6D to go low and discharge C7 each time a zero is present. Thus, for a normal bit stream

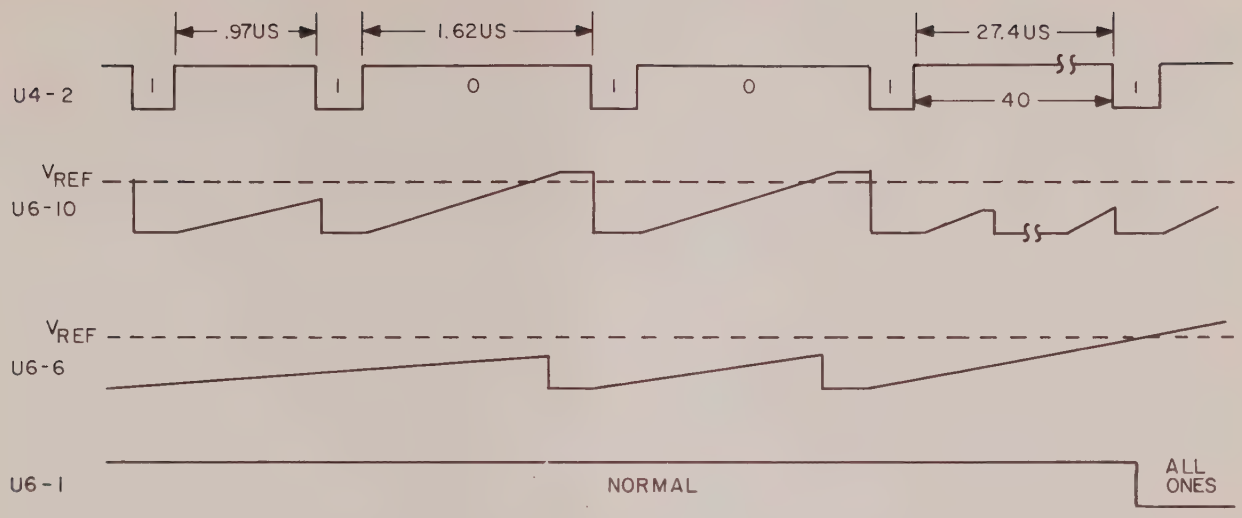

Figure 5—3. All Ones Detector Timing Diagram B-01502

containing random zeros, C7 never charges long enough to exceed the reference voltage. As a result, the normal condition at the output of U6B is a high level.

5.42 When approximately 40 or more successive ones are present, C4 is being repeatedly discharged and the output of U6D is essentially open. This allows C7 to charge to the reference voltage and set the output of U6B low. This condition will prevail as long as the all ones condition persists.

5.43 10 KHZ OSCILLATION DETECTOR

5.44 The so-called 10 kHz oscillations normally fall within the range of 6 to 30 kHz and appear on the span line as square waves. Detection of these oscillations is the function of voltage comparators U6C and U6A and RC time constants R6-C3 and R8-C6.

5.45 For a normal T1 bit stream, the high level at the output of U4A is always considerably less than the time required for C3 to charge to the reference voltage. See Figure 5—4 for the related timing diagram. This forces the output of U6C to be essentially open all of the time. The charge on C6 exceeds the reference voltage and the output of U6A is normally low for a T1 bit stream.

5.46 When oscillations of 37.5 kHz or less are present, the high level at the output of U4A is greater than the time required for C3 to charge to the reference voltage. The first time that this occurs, C6 is discharged and the output of U6A goes high. As long as oscillations persist, C6 will be repeatedly discharged before the reference voltage is reached. This keeps the output of U6A high. When a normal signal returns for greater than 42.2 microseconds, C6 charges to a voltage that is greater than the reference voltage. This returns the output of U6A to the normal low state.

5.47 ERROR DECODING AND LAMP DRIVERS/TIMERS

5.48 There are three sets of lamp drivers/timers and a set of common decoding logic to indicate the presence of one of four possible input conditions. These conditions are a normal error-free T1 input, a T1 input with bipolar violations, all ones oscillations, and 10 kHz oscillations. Each of the four conditions and its associated circuitry is discussed in paragraphs 5.49 through 5.61.

5.49 **Error-Free T1 Input**

5.50 This condition is indicated when only the PULSES lamp is lighted. With an error-free T1 input, the output of U4B is a series of positive pulses. The positive transition of the first pulse triggers one-shot multivibrator U8A. This causes its $\overline{Q}$ output to go low for approximatley 60 milliseconds. The output of U10B also goes low for this period of time and the front-panel PULSES lamp is pulsed on. At the same time, the Q output of U8A triggers one-shot U8B, which requires 100 milliseconds to time out. Thus U8A cannot be retriggered during this time and the lamp is pulsed at a 10 pps rate for a continuous error-free T1 signal.

5.51 The remaining two driver/timer circuits are inhibited as follows. With no all ones or 10 kHz oscillations present, the output of U6B is high and U6A low. The low level inhibits U5A and its output goes high. This is inverted to a low level by U4C, which applies this to one input of U1D. The other input of U1D is also low as there are no bipolar violations and the output of U3C is low. Thus the T1 trigger input of U9A is clamped to a high level and the error one-shot cannot be triggered. With both inputs of U3D high, its output is low and inhibits U5B. This forces its output to be clamped high and prevents triggering of oscillation one-shot U7A.

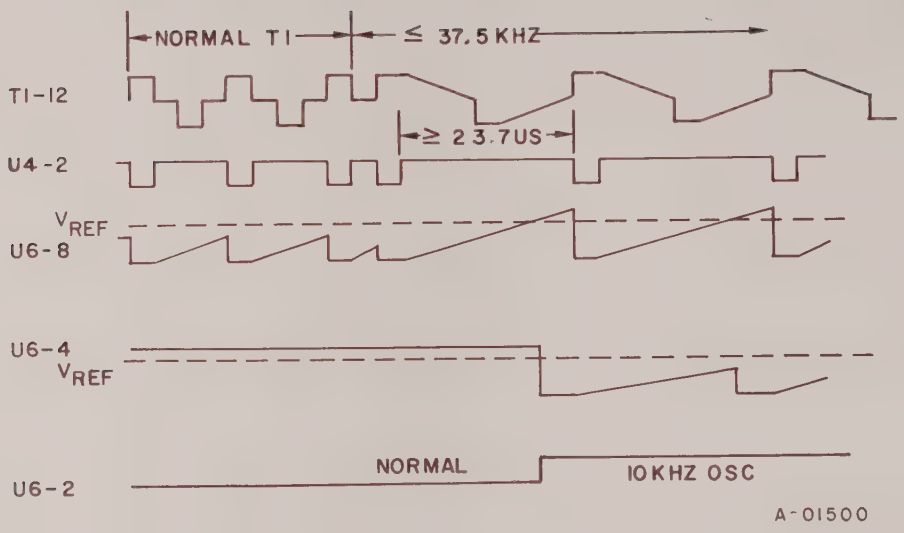

Figure 5—4. 10 kHz Oscillation Detector Timing Diagram

5.52 **T1 Input With Bipolar Violations**

5.53 This condition is indicated when the PULSES and ERRORS lamps are lighted. The PULSES indicator is lighted as described in paragraph 4.50. The ERRORS indicator is lighted as follows. Since there are no 10 kHz oscillations, the low output of U6A inhibits U5A. The high output of this gate is inverted by U4C to a low level that enables one input of U1D. The second input is the series of positive pulses generated by the bipolar violation detector and present at the output of U3C. The first positive transition at the output of U1D triggers U9A, which in turn triggers U9B. The timing of these one-shots is identical to those described in paragraph 5.50 and the ERRORS lamp is pulsed on.

5.54 With no all ones or 10 kHz oscillations present, the output of U6B is high and U6A low, which is inverted to a high level by U4E. Thus both inputs of U3D are high to force its output low. This inhibits U5B to clamp the I1 input of U7A high to prevent triggering of the oscillation driver.

5.55 **All Ones Oscillation**

5.56 This condition is indicated when the PULSES and OSCILLATION lamps are lighted. The PULSES indicator is lighted as described in paragraph 5.50. The OSCILLATION indicator is lighted as follows. With all ones oscillations present, the output of U6B goes low to inhibit U3D and force its output high. This enables one input of U5B and allows the output pulses of U4B to be passed by U5B to the I1 trigger input of oscillation one-shot U7A.

5.57 With no 10 kHz oscillations present, the low output of U6A inhibits one input of U5A. Its high output is inverted by U4C and applied to one input of U1D. Since there are no errors, the second input is also low and the I1 trigger input is clamped at a high level so that no triggering of the errors driver occurs.

5.58 **10 kHz Oscillation**

5.59 This condition is indicated when the ERRORS and OSCILLATION lamps are lighted. The high output of U6A is inverted by U4E and is used to inhibit U3D. Th high output of U3D enables the pulses at the output of U4B to be passed by U5B and trigger the I1 input of U7A.

5.60 Since there are no bipolar violations being detected, the errors driver must be triggered in a different manner. The pulses present at the output of U4B via U5B are passed by U5A, which is enabled by the high output of U6A. These pulses are inverted by U4C and applied through U1D to the I1 trigger input of U9A.

5.61 The pulses driver is inhibited in the following manner. The high at the output of U6A, inverted by U4E, is used to inhibit the CD inputs of U8A and U8B. This prevents triggering of these drivers.

5.62 CURRENT GENERATOR DESCRIPTION

5.63 The current generator and associated circuits are discussed on a functional diagram level referenced to Figure Figure 7—1. Principal circuits involved are the current regulator and the output voltage limiter. Associated circuits include the return current limiter, a high-voltage overload circuit, a high-voltage turn-on safety circuit, and a meter circuit.

5.64 CURRENT REGULATOR

5.65 The source of regulated output current is the 350-volt power supply applied across series pass transistors Q2 and Q3. The pass transistors are driven by emitter follower Q1 which, in turn, is driven by current regulator U2. The regulated current passes through R24, which drops a voltage directly proportional to the load current. One side of R24 is the negative side of the supply voltage for U2 and the other side is tied to a voltage divider comprised of R11, R12, and R13. The other side of the voltage divider is connected to a reference voltage developed within U2. As the voltage drop across R24 tries to change due to the change of span line resistance, U2 senses this change and alters its output voltage in a direction that maintains the output current constant. Current adjust potentiometer R11 allows the output current to be varied from 50 to 160 milliamperes. Zener diode CR21 limits the voltage drop across R24 to an absolute maximum of 5.1 volts. Operating voltage for U2 is supplied by a 20-volt floating power supply. Resistors R1, R2, and R3 provide a minimum load for the current regulator in the event the load becomes shorted.

5.66 OUTPUT VOLTAGE LIMITER

5.67 Sensing lines S+ and S− sense the output voltage directly across the load. This voltage is applied to the negative supply side of voltage limiter U1 and to one side of voltage divider R4, R5, and R6. The other side of the voltage divider is tied to a reference voltage developed within U1. Potentiometer R5 is adjusted so that as the output voltage approaches 270 volts, U1 starts to provide an output that diverts some of the current being used to drive Q1. As the load resistance continues to go up, more and more current is diverted to maintain the output voltage at a maximum of 270 volts.

5.68 RETURN CURRENT LIMITER

5.69 The return current limiting circuit consists of Q4, Q5, CR23, R27, R28, and LED DS3. The entire return current from the load must pass through resistors R27 and R28. They provide a voltage drop proportional to the return current. At approximately 145 milliamperes, the limiter begins to function and at approximately 165 milliamperes it becomes fully operational. Thus the return current is limited to this level. RETURN CURRENT LIMITING indicator DS3 is located in the feedback path and gives an indication of the limiting action.

5.70 HIGH-VOLTAGE OVERLOAD CIRCUIT

5.71 This circuit is placed directly across the LSO and LSI jacks. It can be adjusted to trigger when the dc voltage across these jacks exceeds approximately 300 volts. When this happens, the limiter places a short across the load and load fuse F2 and/or ac line fuse F1 opens. This overload feature exists primarily to protect against a collector-to-emitter short circuit in the series pass transistors. It will, however, operate whenever the output voltage becomes excessive, whatever the reason.

5.72 HIGH-VOLTAGE TURN-ON SAFETY CIRCUIT

5.73 High-voltage safety circuits are designed so that a set of deliberate steps must be taken to activate the current generator. The first requirement is that ground be returned on the sleeve of both the LSO and the LSI jacks. This ensures that there can be no output until all interconnections between the 7007 and the load have been made. Secondly, meter function switch S5A must be set to any position except OFF. Grounded sleeve detectors Q3/Q4 and off detector Q2 enable relay driver Q1 when these two conditions have been met. Now, when HIGH VOLTAGE START switch S4 is momentarily depressed, +5 volts is applied to K1 and the relay energizers. Latching voltage for the relay is applied through a normally-open set of contacts. Another set of normally-open relay contacts applies ground to HIGH VOLTAGE ON indicator DS2. This same set of contacts causes K2 to energize. Contacts K2-A connect the current regulator output to emitter follower Q1, which then drives the pass transistors. The K2-1A contacts complete the return current path for the limiter circuit.

5.74 METER CIRCUIT

5.75 This circuit, through appropriate switching and series and shunt resistors, displays on M1 the important currents and voltages at the input and output jacks.

SECTION 6

MAINTENANCE AND CALIBRATION

6.1 INTRODUCTION

6.2 This section provides service information, periodic maintenance and calibration procedures.

6.3 SERVICE INFORMATION

6.4 The high voltage power supply assembly located at the rear of the unit and the switch board assembly mounted behind the front panel contain dangerous high voltages. Both assemblies are equipped with protective covers that are **not** to be removed exept by authorized personnel at the factory. For repair and/or calibration of either of these assemblies, the unit must be returned to the factory.

6.5 Prior to return of the unit to the factory, obtain written authorization from Northeast Electronics. Additional service information can be obtained by contacting Northeast Electronics Customer Service Department, P.O. Box 649, Concord, New Hampshire 03301, telephone number 603-224-6511.

6.6 PERIODIC MAINTENANCE

6.7 Approximately once a month, check the security of the screw access caps that are part of the black plastic transistor insulating covers. They are located on the rear heatsink. If a cap is loose, apply a drop of vinyl adhesive cement to the cap and then replace the cap. If a cap is missing, fill the screw access hole with silicone rubber.

6.8 Approximately every six months, apply a small amount of boiled linseed oil to the wooden handles. Rub the oil throughly into the wood and then use a soft cloth to remove any excess.

6.9 CALIBRATION

6.10 By stopping short of the actual adjustments normally appearing near the end of the procedures, the following calibration procedures can also be used as performance checks of the set's adjustable parameters. Make the adjustments only when the measured parameter is outside of the stated tolerance. Those parameters that can be adjusted are: (1) the QRSS signal level present at both the QRSS OUTPUT and the LSO jacks, (2) the oscillations detector characteristics, and (3) the output current. A list of required test equipment is provided in Table 6—1.

Table 6—1. Required Test Equipment

Equipment Nomenclature	Required Specifications	Recommended (Or Equivalent)
Oscilloscope	Bandwidth: 10 MHz min Vert Sens: 0.1 V/cm Sweep Speed: 0.5 us/cm Channels: Dual	Tektronix 465
Digital Multimeter	Voltage Range: Up to 300 Vdc Current Range: Up to 170 mAdc Accuracy: 0.1% of full scale Input Impedance: 10 Megohms min	Tektronix DM 501
T1 Signal Generator	Freq: 1.544 Megabits/sec Level: 2.72 V peak-to-peak min Format: All ones	
Square Wave Generator	Freq: 10 to 30 kHz variable Level: 2.72 V peak-to-peak min	

Table 6—1. cont'd

Equipment Nomenclature	Required Specifications	Recommended (Or Equivalent)
Dummy Load	Resistance: 1000 to 1200 ohms Wattage: 35 watts min Jacks: Dual 310	See Figure 4—9
Load Resistor	Resistance: 100 ohms ± 1%	

6.11 QRSS OUTPUT LEVEL ADJUSTMENT

6.12 This procedure sets the QRSS signal level at the QRSS OUTPUT and the LSO jacks to 6V peak-to-peak into 100 ohms. To make these adjustments, perform the following steps.

NOTE

The following procedure does not require activation of the high voltage power supply.

a. Ensure that the ac power cord is **not** connected to an ac power source.

b. At the rear heatsink, remove the three screws that secure the cover and remove the cover.

c. Connect a 100-ohm ± 1% resistor across the tip and ring of a dummy 310 plug and then insert it into the QRSS OUTPUT jack.

d. Connect the 7007 ac power plug to a 117 Vac, 60 Hz power source.

e. Set the POWER switch to the ON position. The POWER indicator should be lighted.

f. Connect a separate oscilloscope probe to each side of the 100-ohm resistor. Connect both probe ground leads to the 7007 chassis.

g. Connect the oscilloscope external triggering jack to the SYNC standoff on the signal generator circuit board.

h. On the oscilloscope, set the vertical mode to added and invert one channel. Select the external triggering source and set the vertical sensitivity and sweep speed to obtain a measureable display.

i. The level of the displayed signal must be 6V peak-to-peak ± 10% measured from the center of one pulse to the center of an adjacent pulse.

j. If required, locate potentiometer R8 on the signal generator circuit board (Figure 6—1) and adjust to obtain a signal level of 6V peak-to-peak on the oscilloscope.

k. To secure the adjustment, place a drop of glyptol on the potentiometer.

l. Remove the dummy 310 plug and resistor from the QRSS OUTPUT jack and insert it into the LSO jack.

m. Connect oscilloscope probes across the resistor on the plug.

n. The displayed signal level must be 6V peak-to-peak ± 10% measured from the center of one pulse to the center of an adjacent pulse.

o. If required, locate potentiometer R6 on the signal generator circuit board (Figure 6—1) and adjust to obtain a signal level of 6V peak-to-peak on the oscilloscope.

p. To secure the adjustment, place a drop of glyptol on the potentiometer.

q. Set the POWER switch to the down position.

r. Replace the cover and secure.

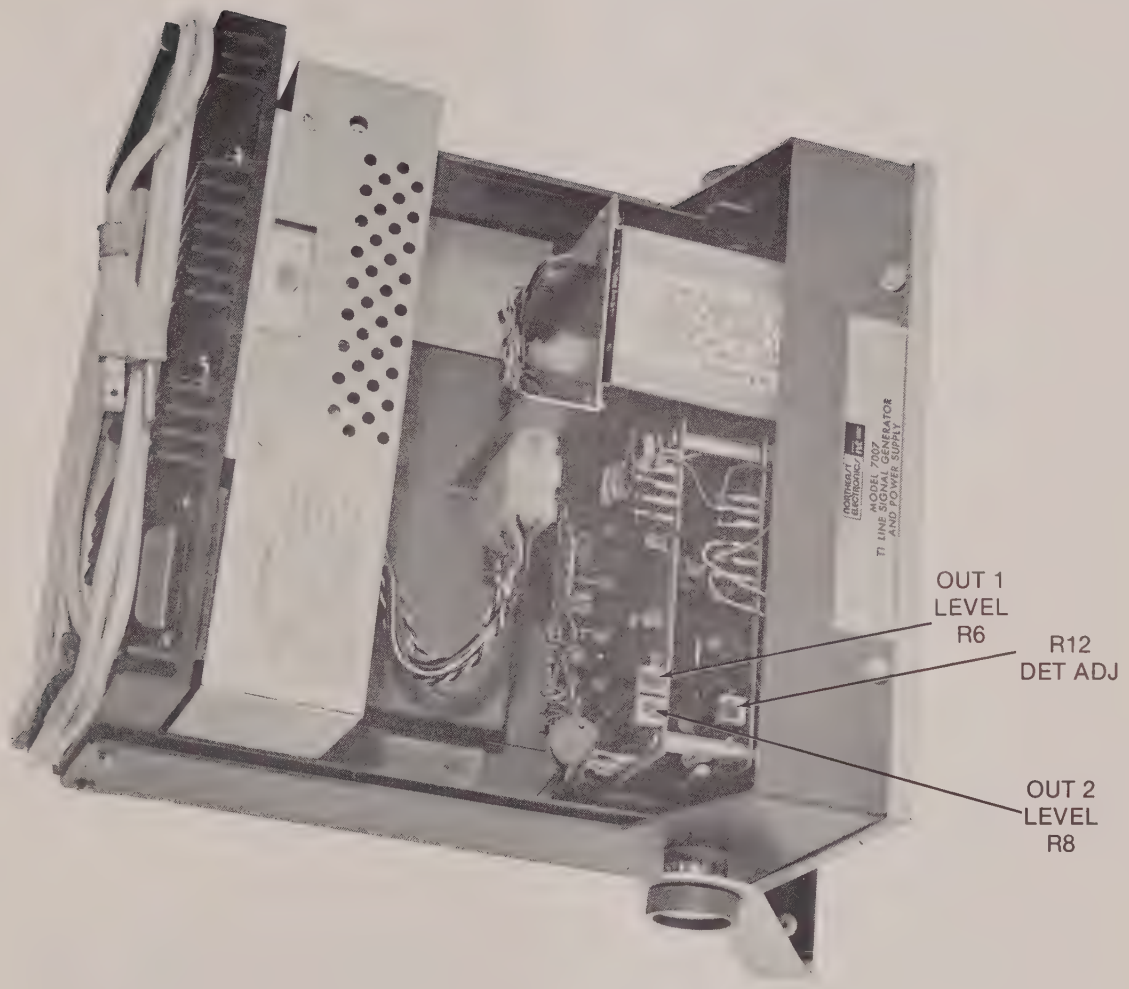

Figure 6—1. QRSS Generator And Oscillation Detector Adjustments

6.13 OSCILLATION DETECTOR ADJUSTMENT

6.14 This procedure sets the operating points of the oscillation detectors so that the all ones detector can distinguish between a normal T1 bit stream containing random zeros and one that is comprised of all ones. It also sets the 10 kHz oscillation detector to function at 37.5 kHz and below. To adjust the detectors, perform the following steps.

NOTE

The following procedure does not require activation of the high voltage power supply.

a. Ensure that the ac power cord is **not** connected to an ac power source.

b. At the rear heatsink, remove the three screws that secure the cover and then remove the cover.

c. Connect square wave generator to DET INPUT jack.

d. Set square wave generator frequency to 37.5 kHz and the output level to 3 volts peak-to-peak.

e. Plug the ac power cord into a power source.

f. Set the POWER switch to the ON position.

g. On the error detector circuit board (Figure 6—1) locate the oscillation detector adjustment and carefully adjust until both the ERRORS and OSCILLATION indicators are just lighted. This automatically sets the operating point of the all ones detector.

h. Set the POWER switch to the down position.

i. Replace the cover and secure.

6.15 OUTPUT CURRENT ADJUSTMENT

6.16 The output current is normally set to 140 milliamperes at the factory. It can, however, be set to any level within the range of 50 to 160 milliamperes. To adjust the output current, perform the following steps.

WARNING

When the 7007 high voltage power supply is operating, dangerous voltages are present in the unit.

a. Fabricate a dummy load as shown on Figure 4—9.

b. Using a test cord equipped with dual 310 plugs at each end, connect the LSO and LSI jacks to the dummy load.

c. Insert the 7007 ac power plug into a power source.

d. Set the POWER switch to the ON position. The POWER indicator should be lighted.

e. Set the 7007 meter function switch to the +I position.

f. Momentarily depress the HIGH VOLTAGE START pushbutton. The HIGH VOLTAGE ON indicator should be lighted.

g. Remove the adjustment access cap located on the top cover of the 7007.

h. Using a small insulated screwdriver or alignment tool, adjust the output current (within the range of 50 to 160 milliamperes) to obtain the desired current indication on the front panel meter.

NOTE

Above 140 milliamperes, the RETURN CURRENT LIMITING lamp will be partially turned on. This may not be noticable in high ambient light conditions.

i. Replace the adjustment access cap.

j. Set the POWER switch to the down position.

SECTION 7

DIAGRAMS

7.1 INTRODUCTION

7.2 Figures 7—1 through 7—3 are the functional diagrams and Figures 7—4 through 7— 13 are the component location diagrams and the schematic diagrams for the Model 7007.

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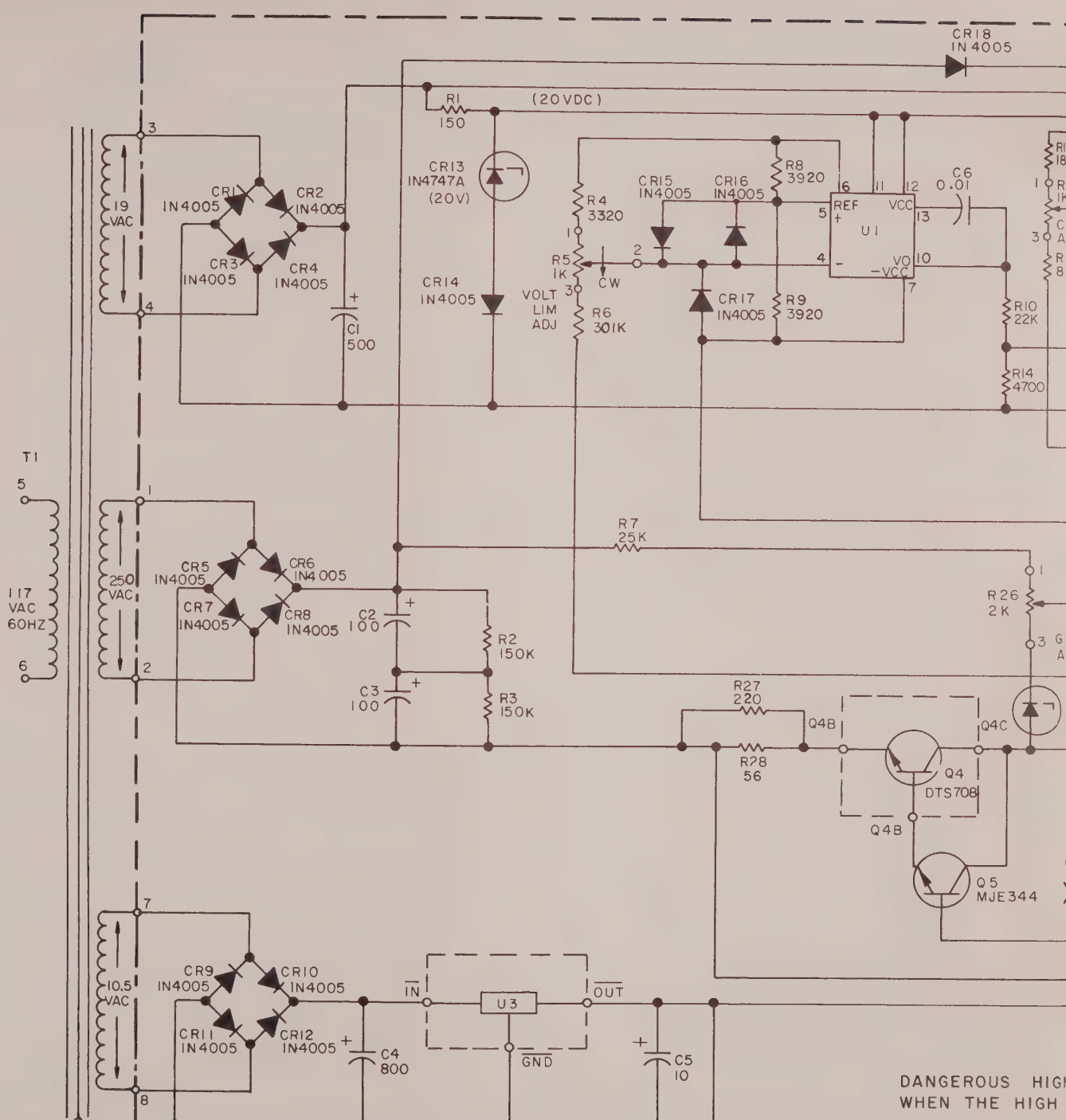
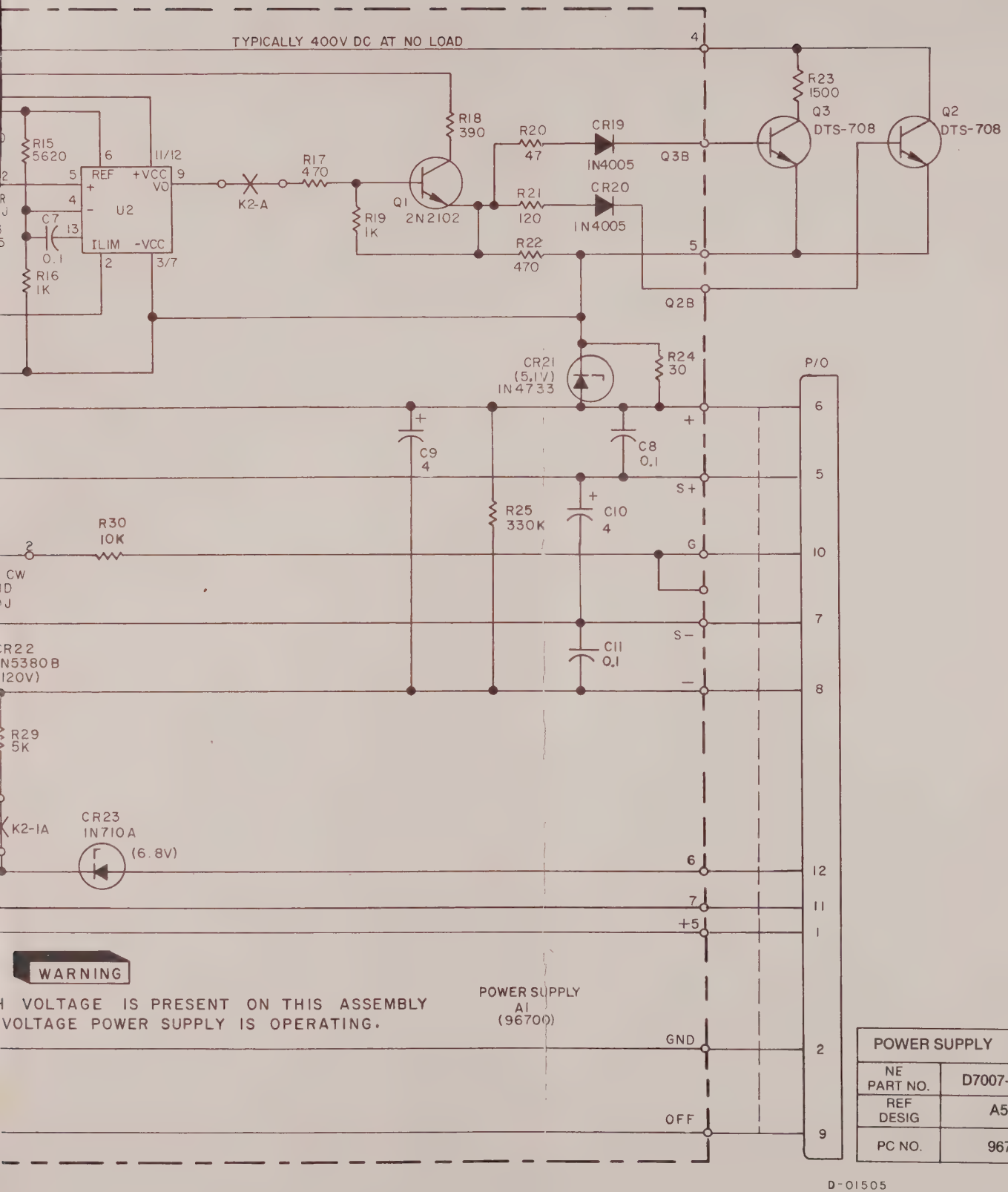


NOTES:

1. RESISTORS IN OHMS AND CA
2. RELAYS SHOWN DEENERGIZED.
3. R5 ADJUSTED TO PRODUCE 270 +
4. R11 ADJUSTS OUTPUT CURRENT
5. I RETURN LIMITING (Q4 AND 5) LI

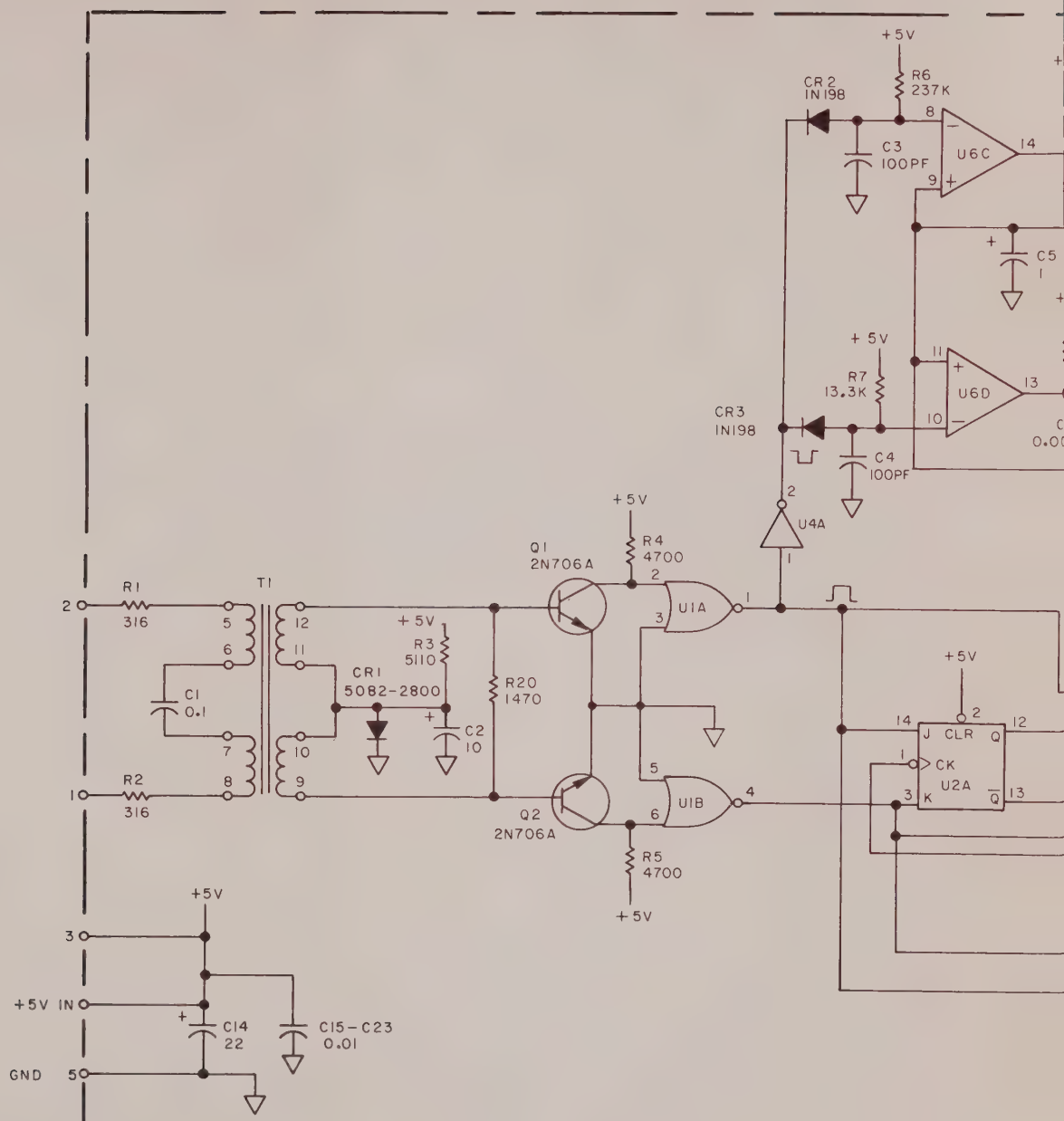


POWER SUPPLY	
NE PART NO.	D7007-00-012
REF DESIG	A5A1
PC NO.	96700

'ACITORS IN MICROFARADS.

-1 VDC BETWEEN S+ AND S-.
'ROM 30 MADC TO 160 MADC INTO 1200 OHM LOAD
ITS CURRENT TO 165 ± 15 MADC AT 60VDC.

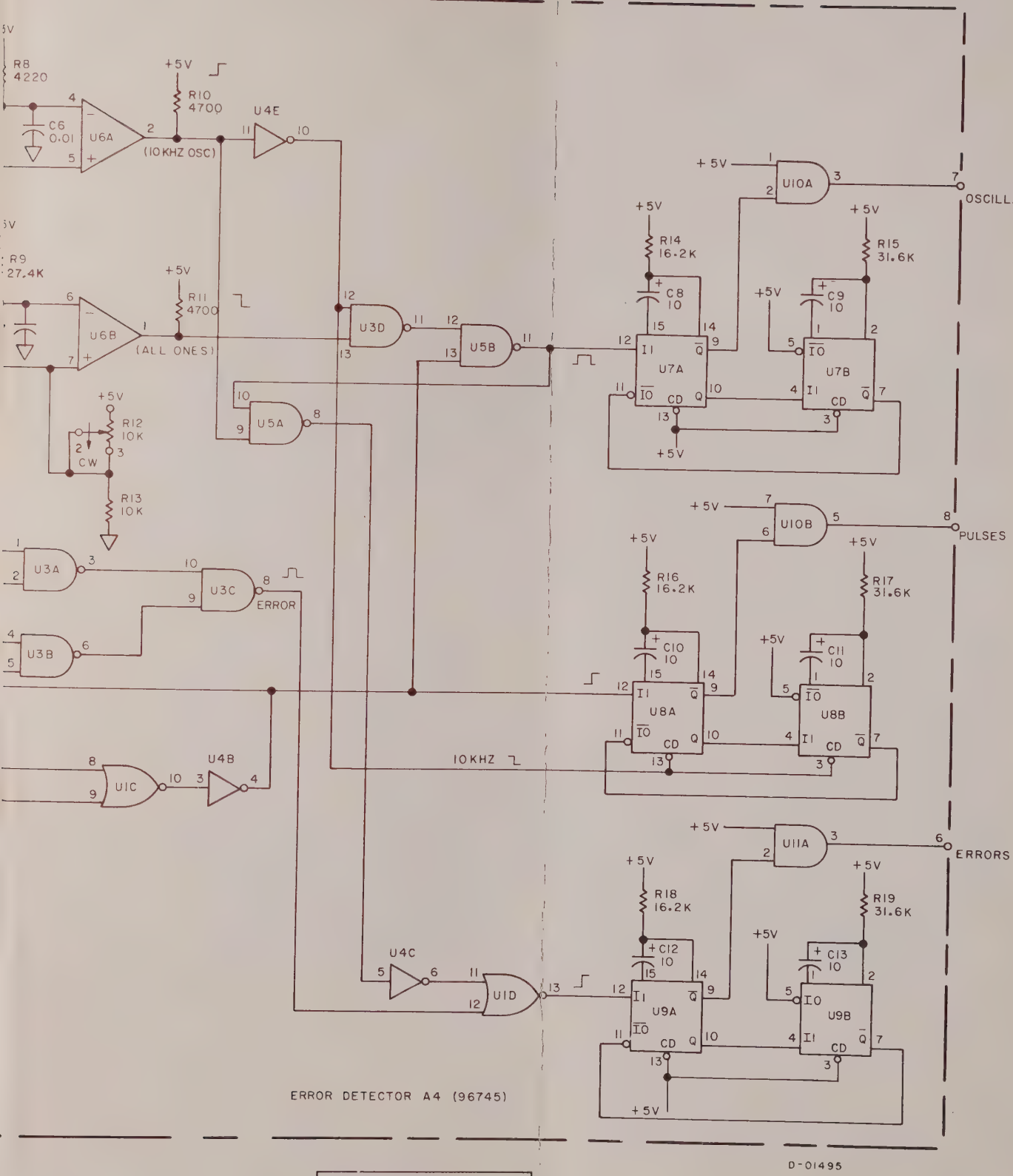
Figure 7—13. Power Supply Circuit Board A5A1 (96700) Schematic Diagram



I.C.	TYPE	GND	+5V	CAP
U1	SN7402N	7	14	C19
U2	SN7473N	11	4	C20
U3, U5	SN7400N	7	14	C21,18
U4	SN7404N	7	14	C22
U6	LM339N	12	3	C23
U7,U8,U9	9602PC	8	16	C15,16,17
U10, U11	SN7545IBP	4	8	——

NOTES:

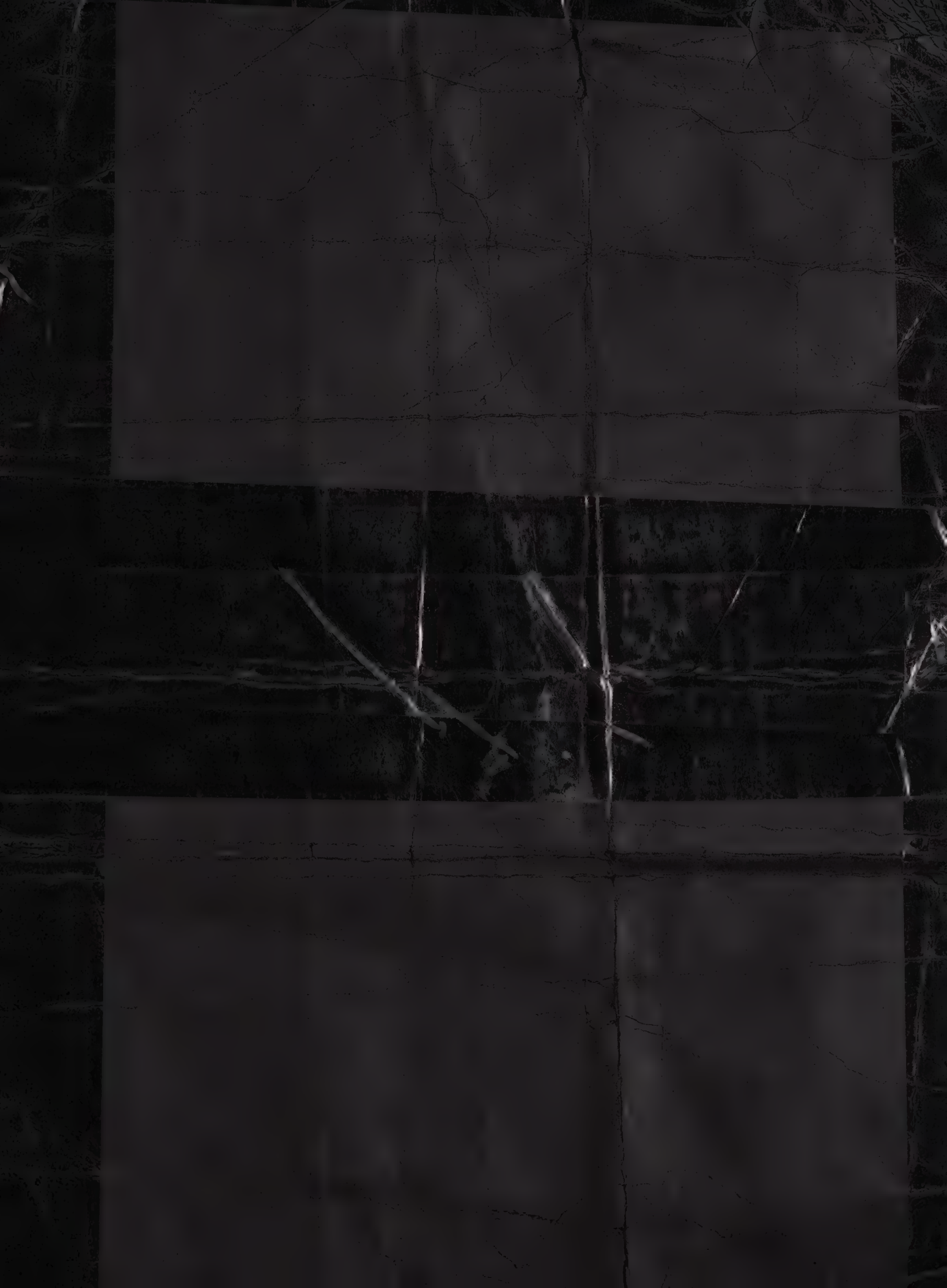
1. RESISTORS IN
   CAPACITORS
2. CAPACITORS C
   DECOUPLING.



ERROR DETECTOR	
NE PART NO.	C7007-00-015
REF DESIG	A6A4
PC NO.	96742

OHMS AND
MICROFARADS.
5-C23 FOR +5V

7–11. Error Detector Circuit Board A6A4 (96742) Schematic Diagram



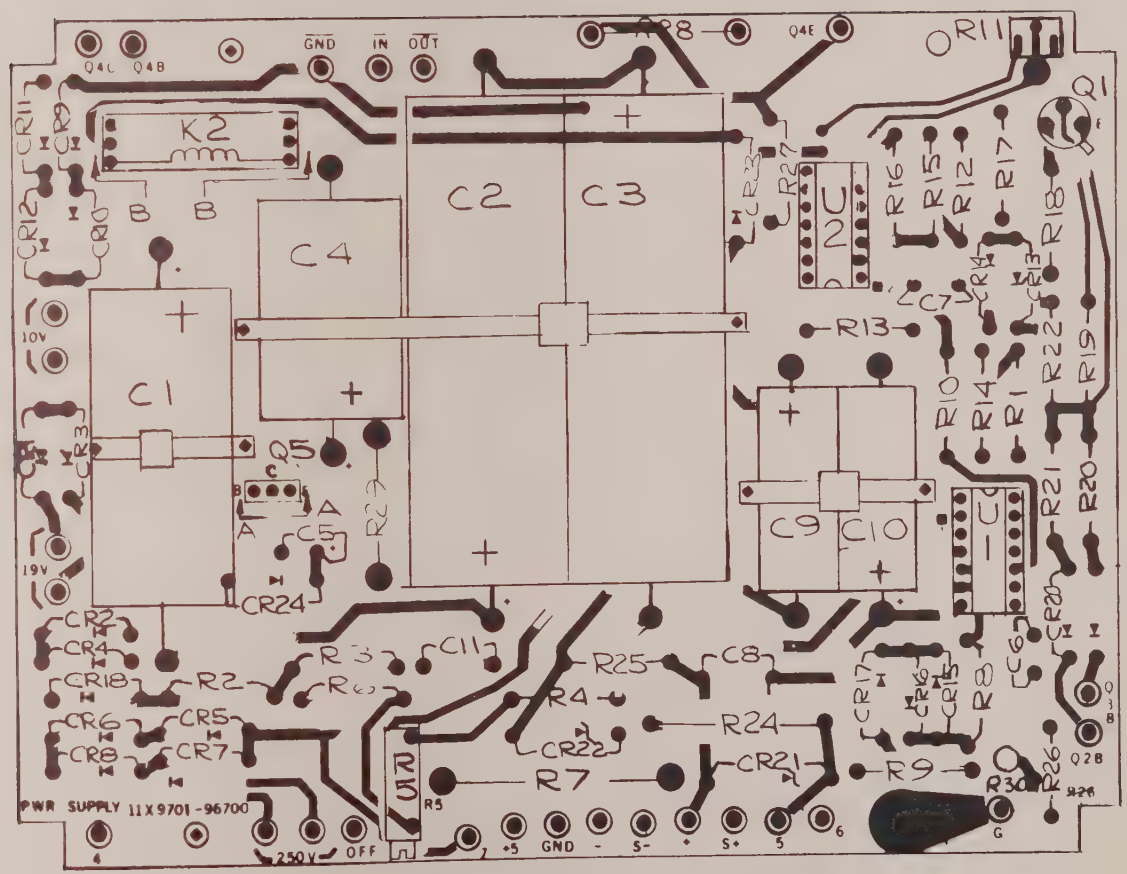
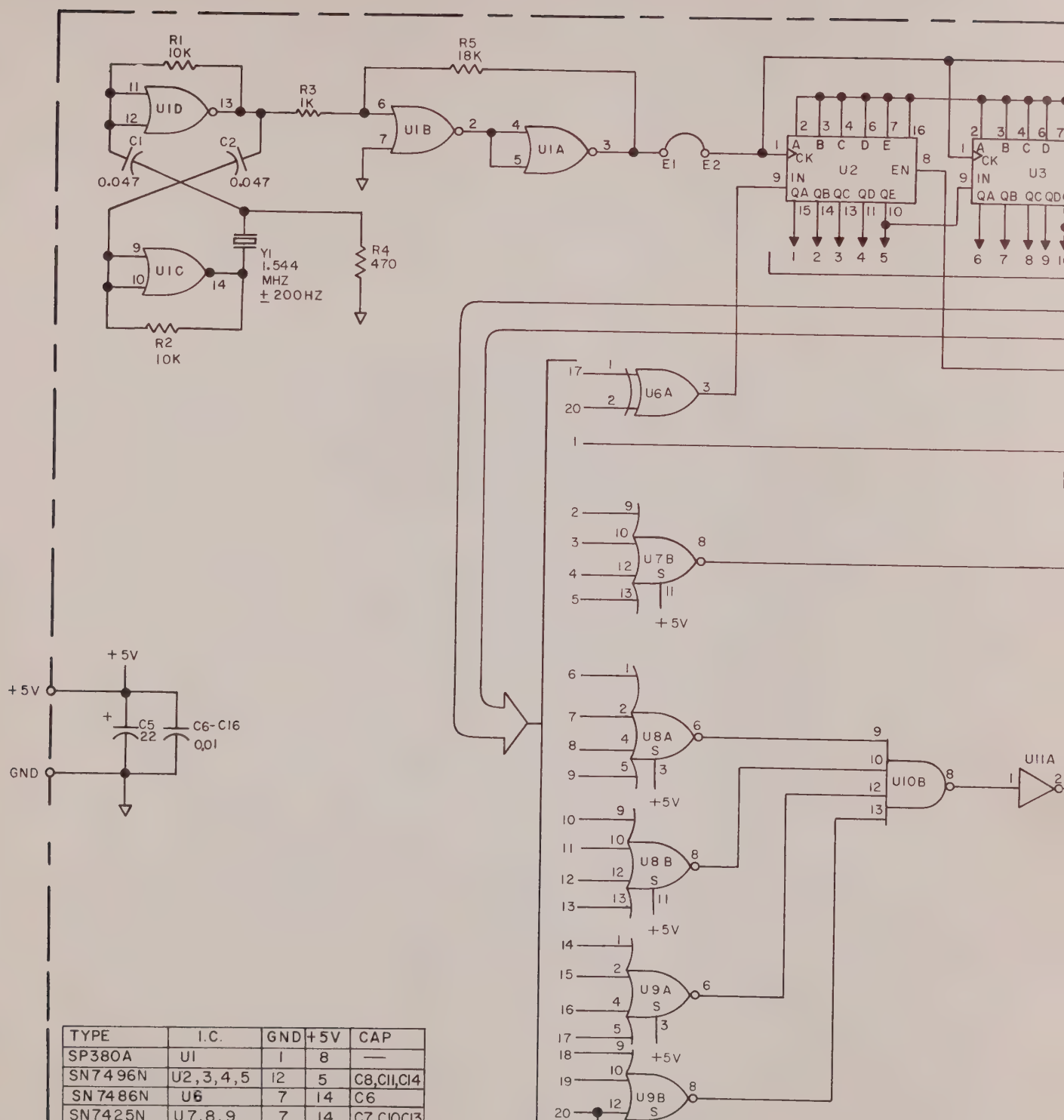


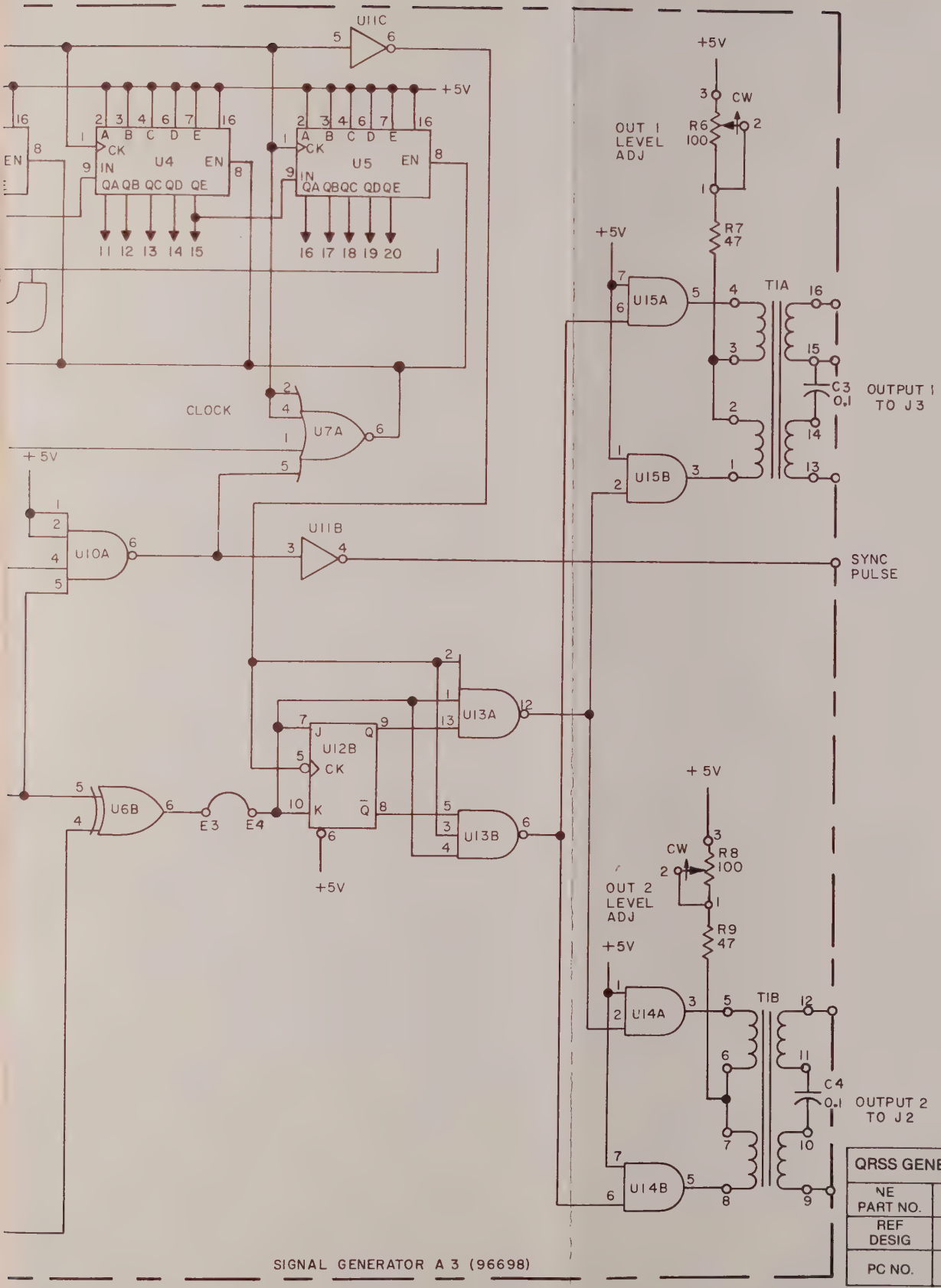
Figure 7—12. Power Supply Circuit Board A5A1 (96700) Component Location



TYPE	I.C.	GND	+5V	CAP
SP380A	U1	1	8	—
SN7496N	U2,3,4,5	12	5	C8,C11,C14
SN7486N	U6	7	14	C6
SN7425N	U7,8,9	7	14	C7,C10,C13
SN7420N	U10	7	14	C9
SN7404N	U11	7	14	C12
SN7473N	U12	11	4	C16
SN7410	U13	7	14	C15
SN75451	U14,U15	4	8	—

NOTES

1. RESISTORS IN O
2. CAPACITORS C6

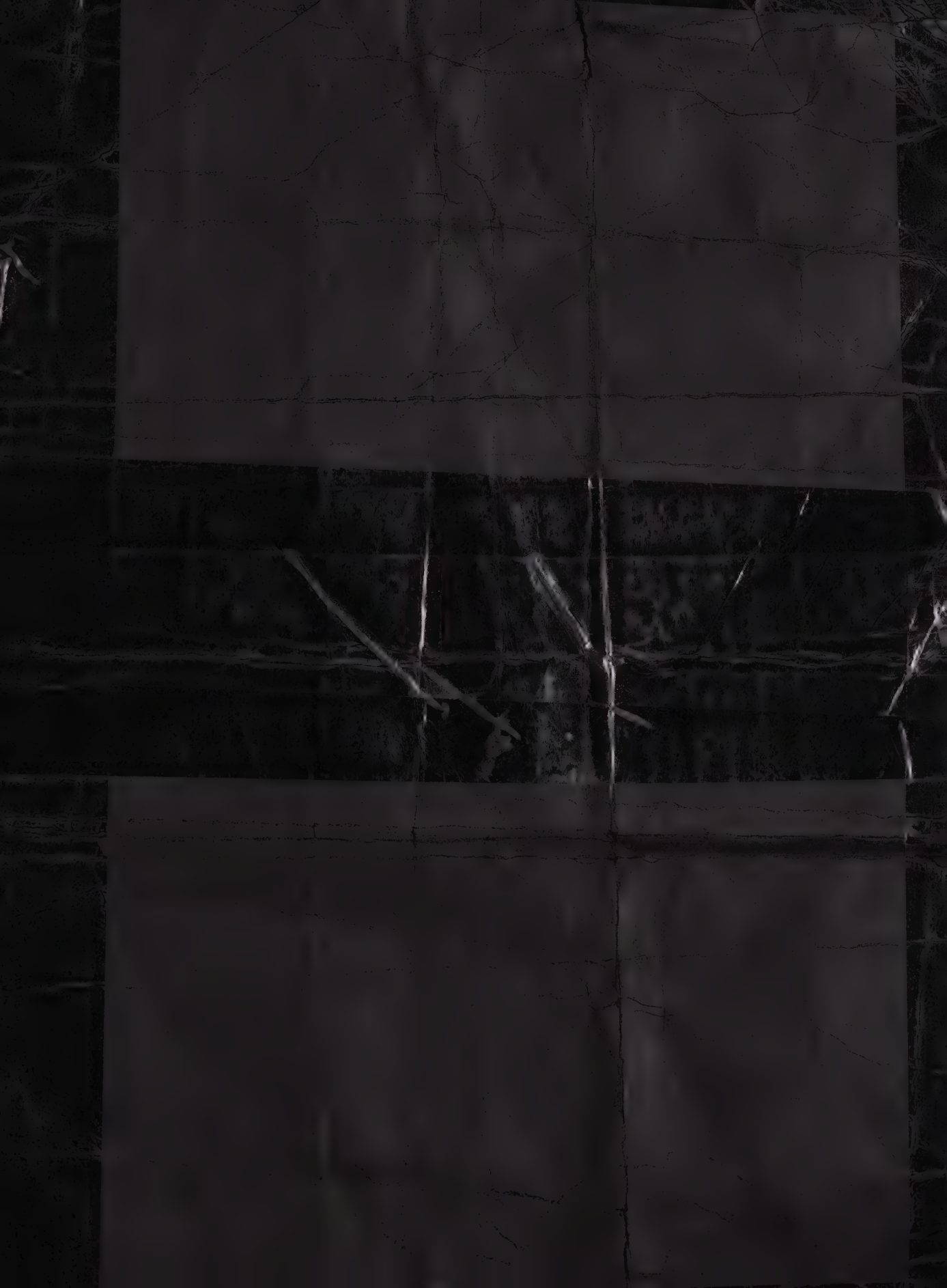


QRSS GENERATOR	
NE PART NO.	B7007-00-014
REF DESIG	A6A3
PC NO.	96698

IMS AND CAPACITORS IN MICROFARADS.
C16 FOR +5V DECOUPLING.

D-01496

Figure 7–9 QRSS Generator Circuit Board A6A3 (96698) Schematic Diagram



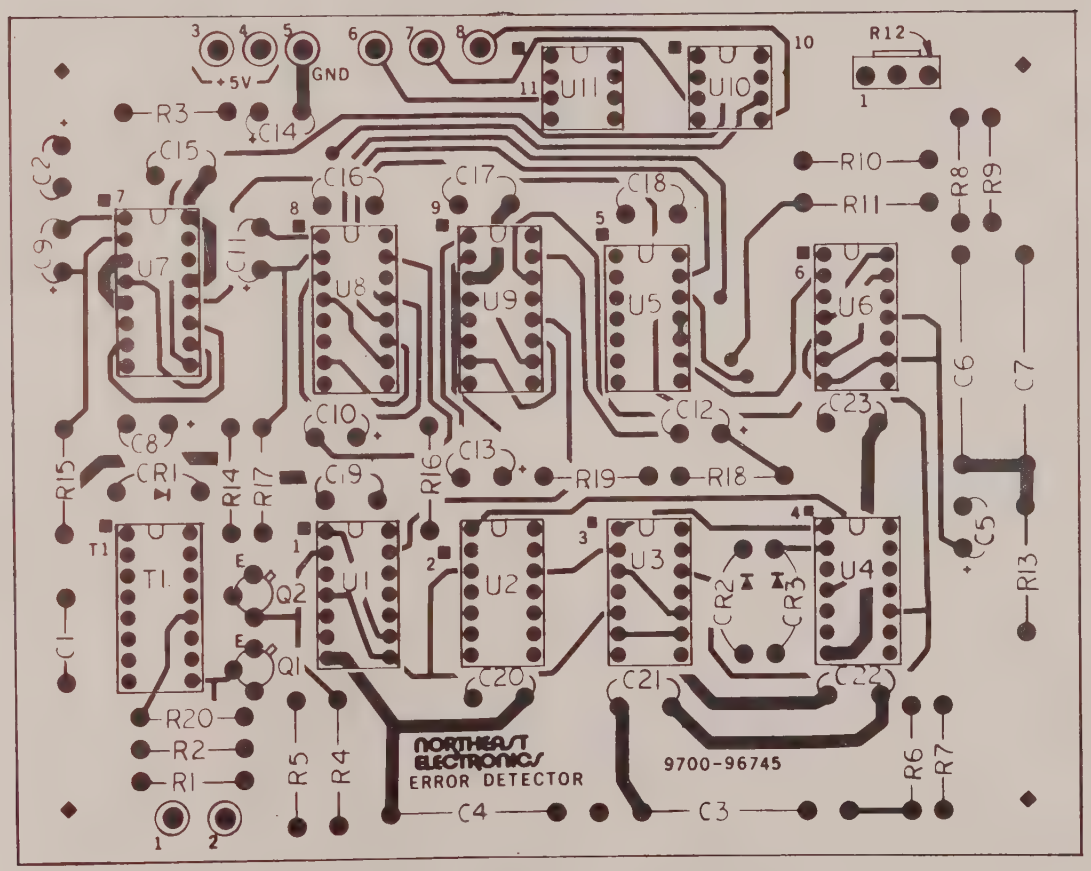
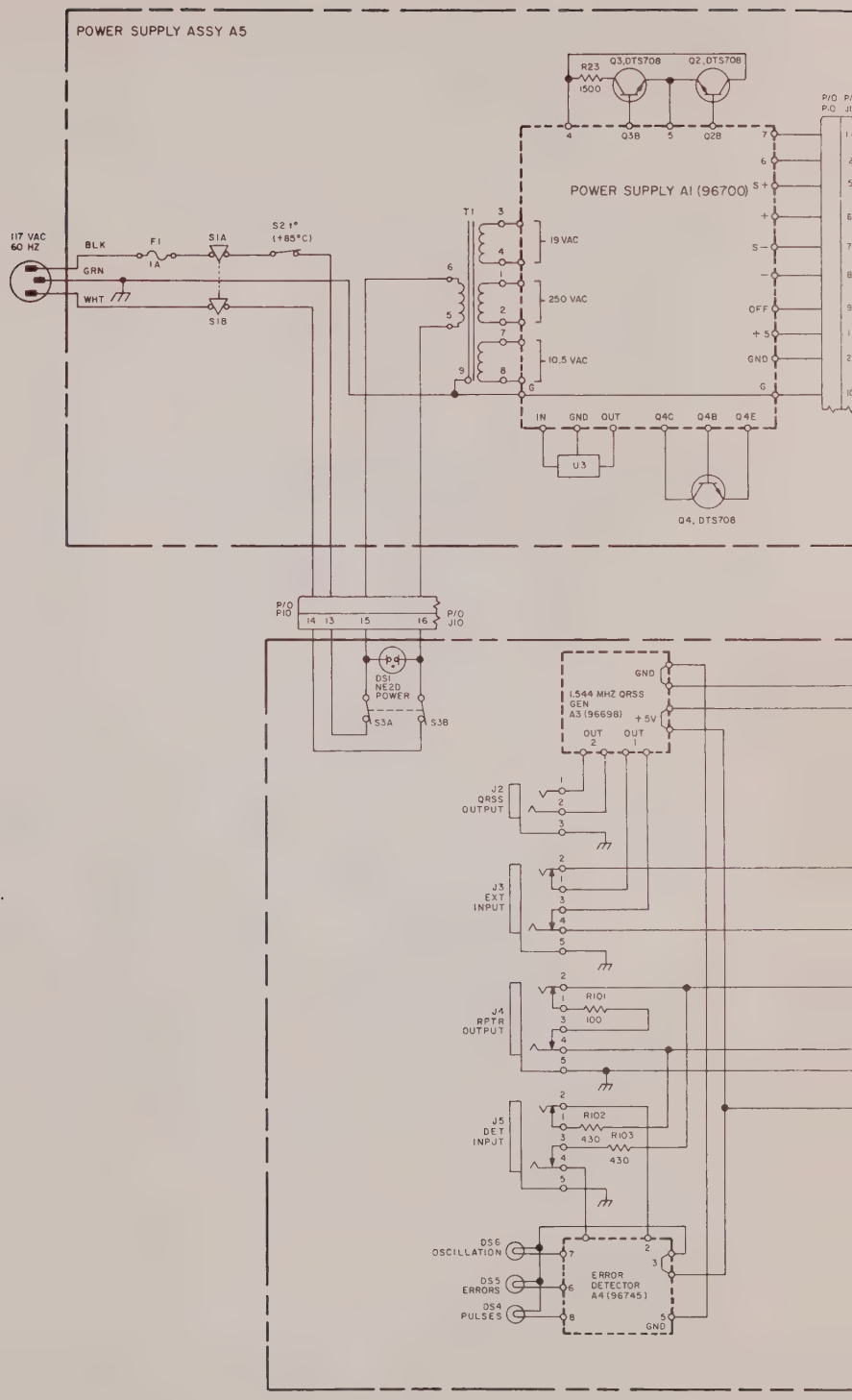
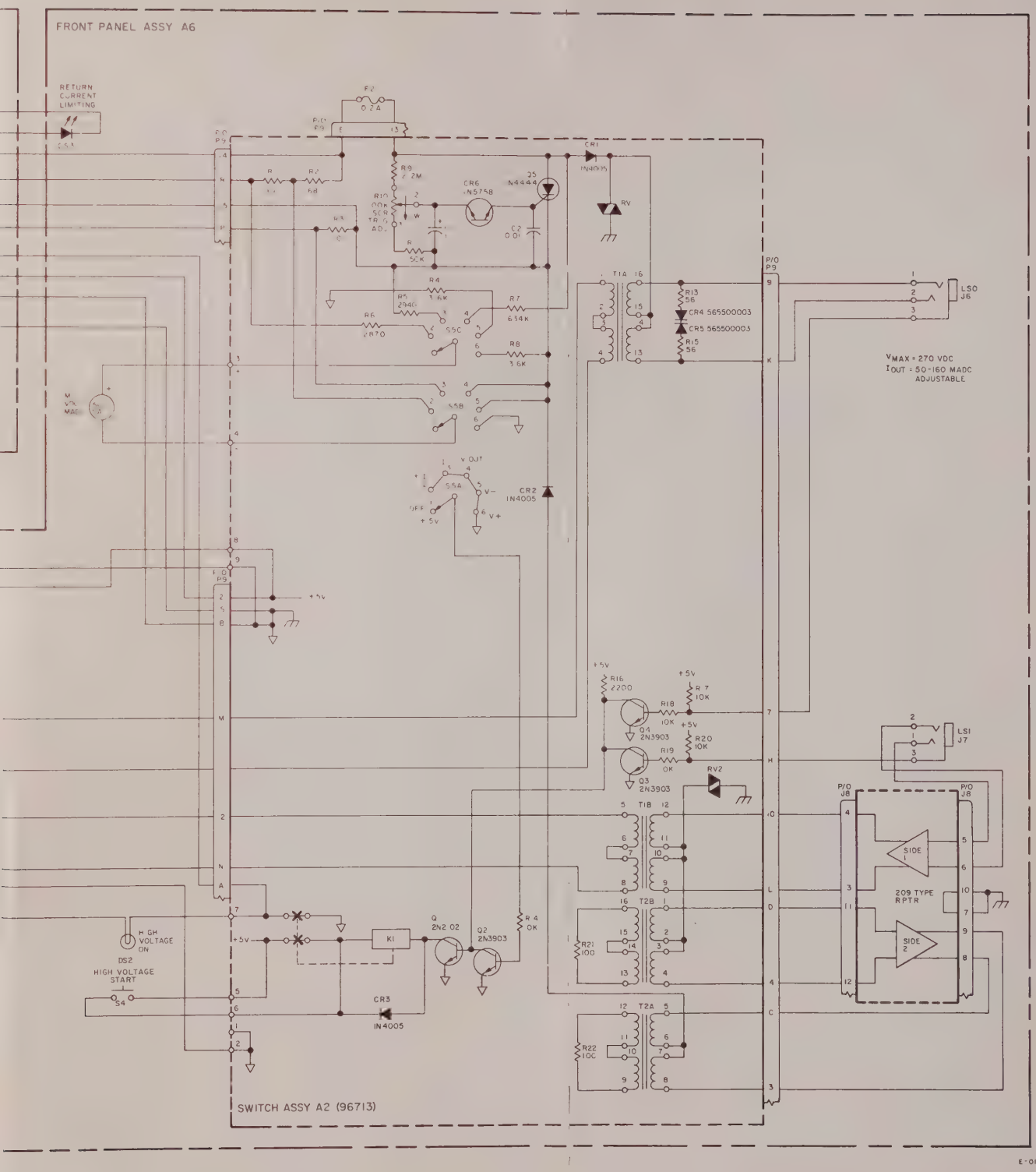


Figure 7—10. Error Detector Circuit Board A6A4 (96742) Component Location


POWER SUPPLY ASSY A5
R23
1500
Q3, DTS708
Q2, DTS708
Q3B
Q2B
POWER SUPPLY A1 (96700)
117 VAC
60 HZ
BLK
GRN
WHT
F1
1A
S1A
S1B
S2 1°
(+85°C)
T1
19 VAC
250 VAC
10.5 VAC
OFF
+5
GND
IN
GND
OUT
Q4C
Q4B
Q4E
U3
Q4, DTS708
P/O
P10
P/O
J10
DS1
NE2D
POWER
S3A
S3B
1.544 MHZ QRSS
GEN
A3 (96698)
+5V
OUT
J2
QRSS
OUTPUT
J3
EXT
INPUT
J4
RPTR
OUTPUT
R101
100
J5
DET
INPUT
R102
430
R103
430
DS6
OSCILLATION
DS5
ERRORS
DS4
PULSES
ERROR
DETECTOR
A4 (96745)

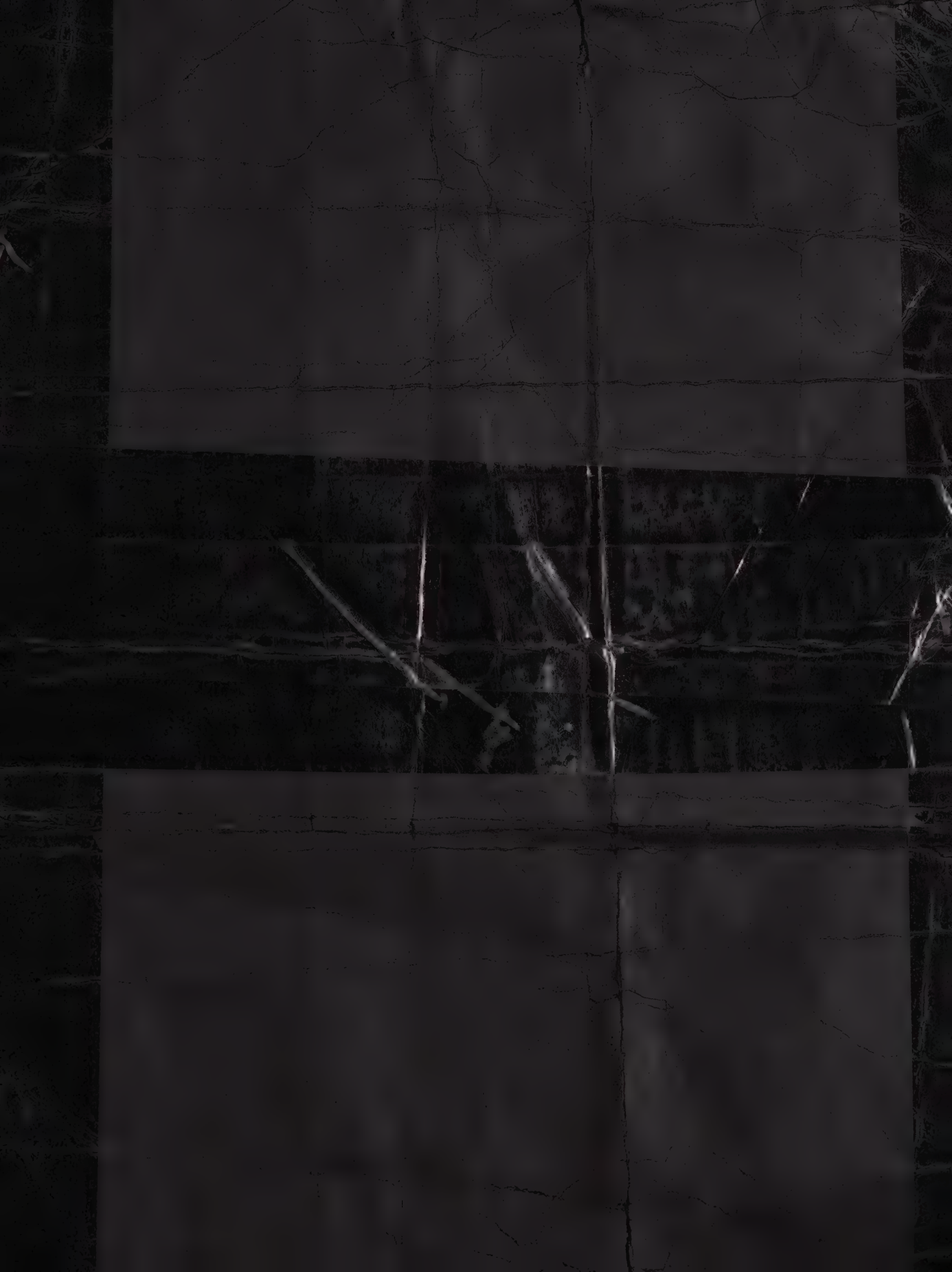


WARNING

DANGEROUS HIGH VOLTAGE IS PRESENT WHEN THE HIGH VOLTAGE POWER SUPPLY ON A5A1 IS OPERATING.

NOTES
1 RESISTORS IN OHMS AND CAPACITORS IN MICROFARADS.
2 RELAYS SHOWN DEENEGIZED.

Figure 7—7. Model 7007 Interconnection Diagram



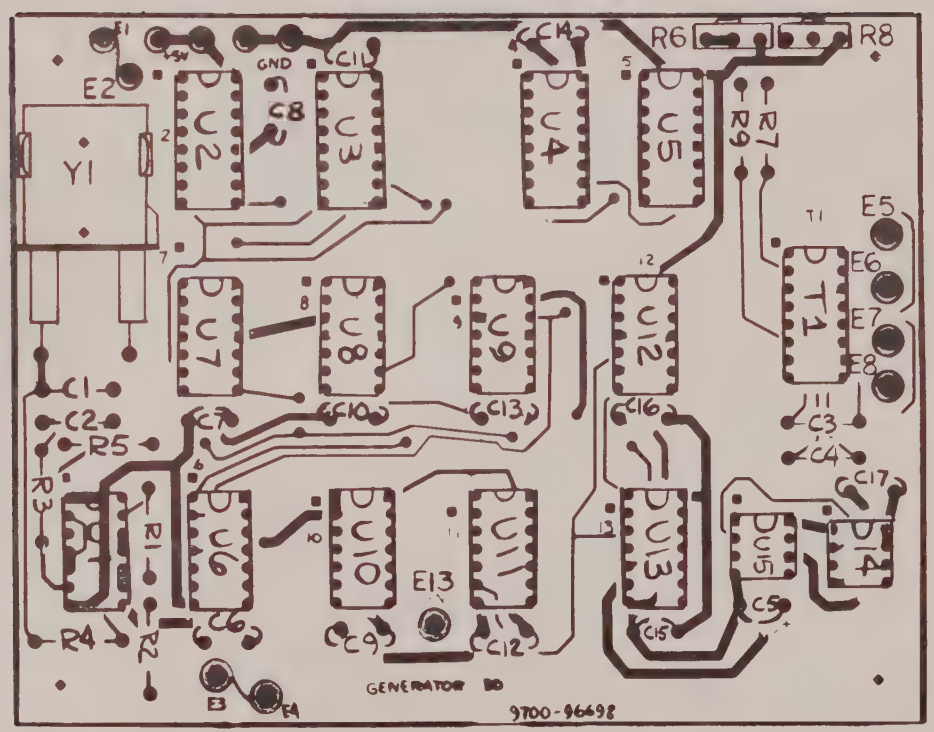
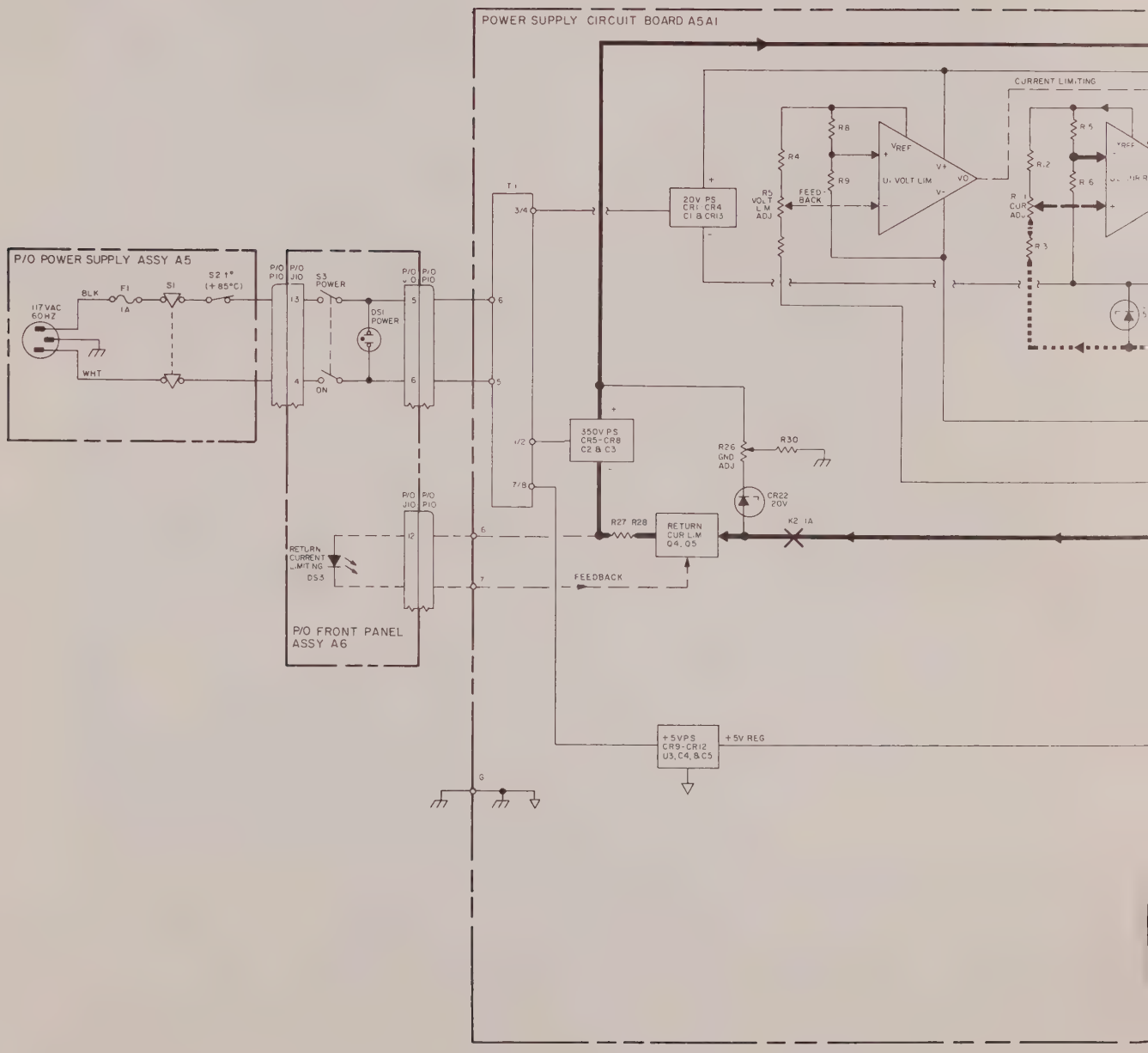


Figure 7—8. QRSS Generator Circuit Board A6A3 (96698) Component Location


POWER SUPPLY CIRCUIT BOARD A5A1
CURRENT LIMITING
P/O POWER SUPPLY ASSY A5
117 VAC 60 HZ
BLK
WHT
F1 1A
S1
S2 1° (+85°C)
S3 POWER
DS1 POWER
ON
P/O P/O J10 P10
T1
3/4
1/2
7/8
20V PS CR1-CR4 C1 & CR15
350V PS CR5-CR8 C2 & C3
R4
R8
R9
R5 VOLT LM ADJ
FEED-BACK
VREF
V+
V-
VO
VOLT LIM
R2
R5
R6
R3
R26 GND ADJ
R30
CR22 20V
R27 R28
RETURN CUR LIM Q4, Q5
K2 1A
RETURN CURRENT LIMITING DS3
FEEDBACK
P/O FRONT PANEL ASSY A6
+5VPS CR9-CR12 U3, C4, & C5
+5V REG
G

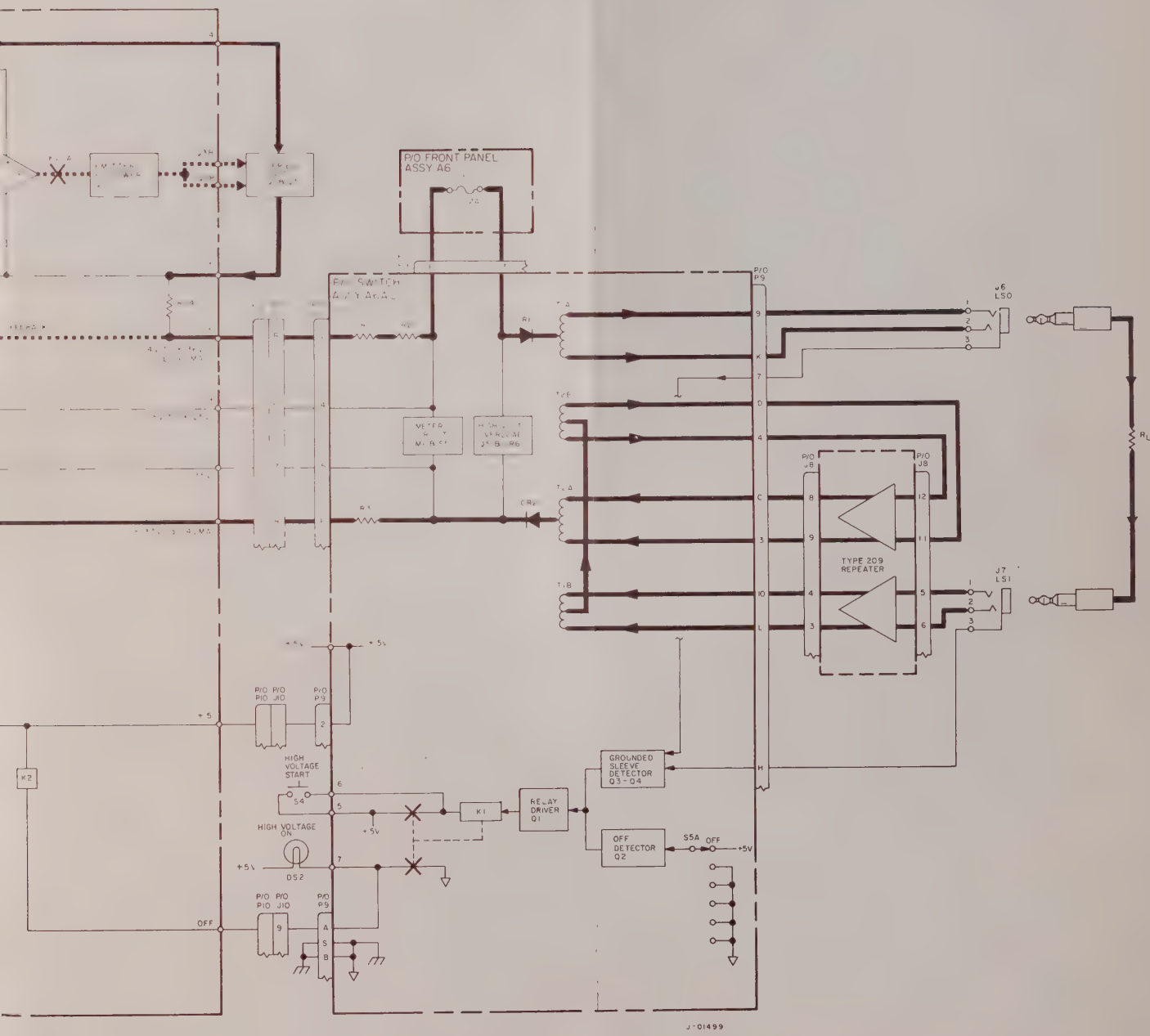
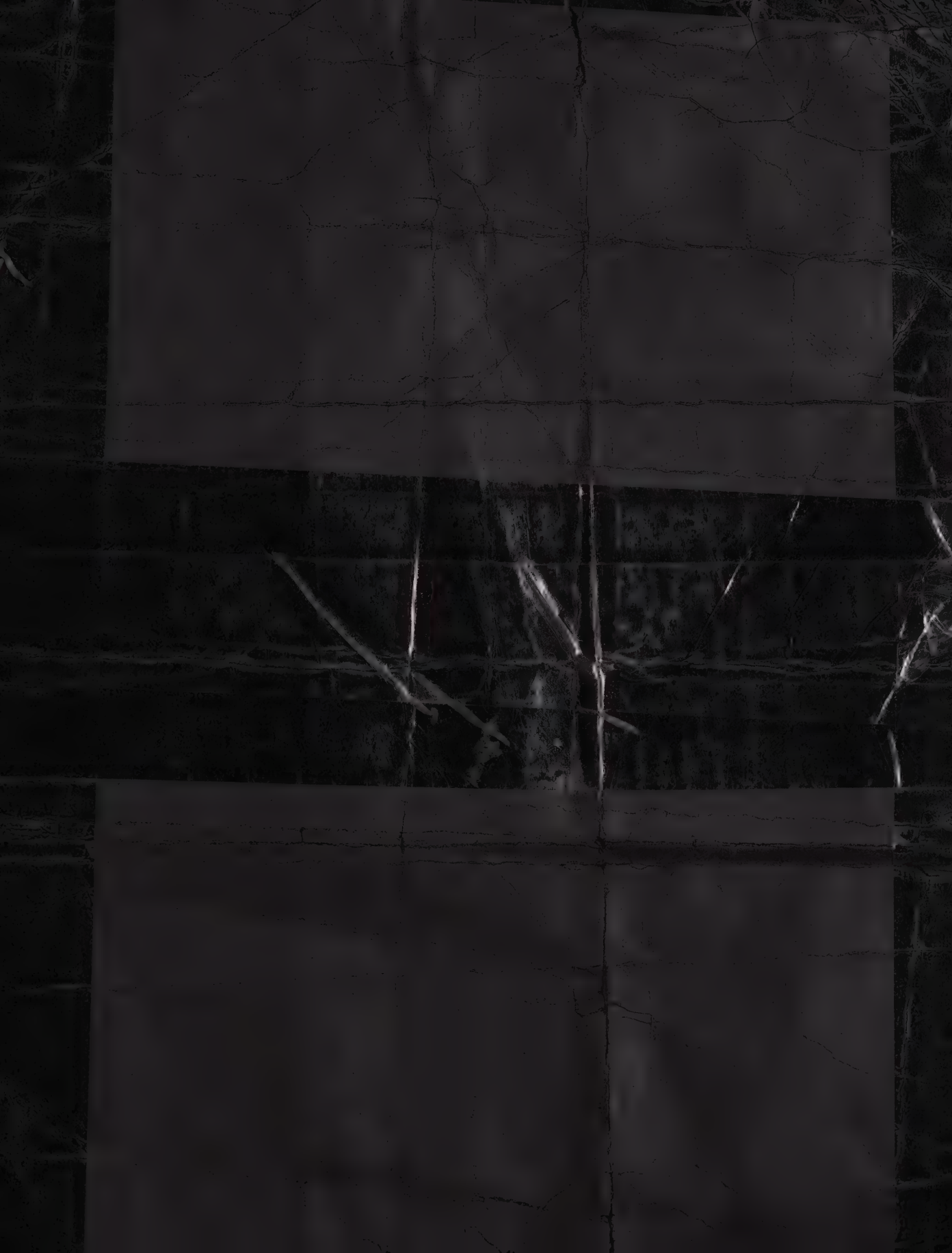
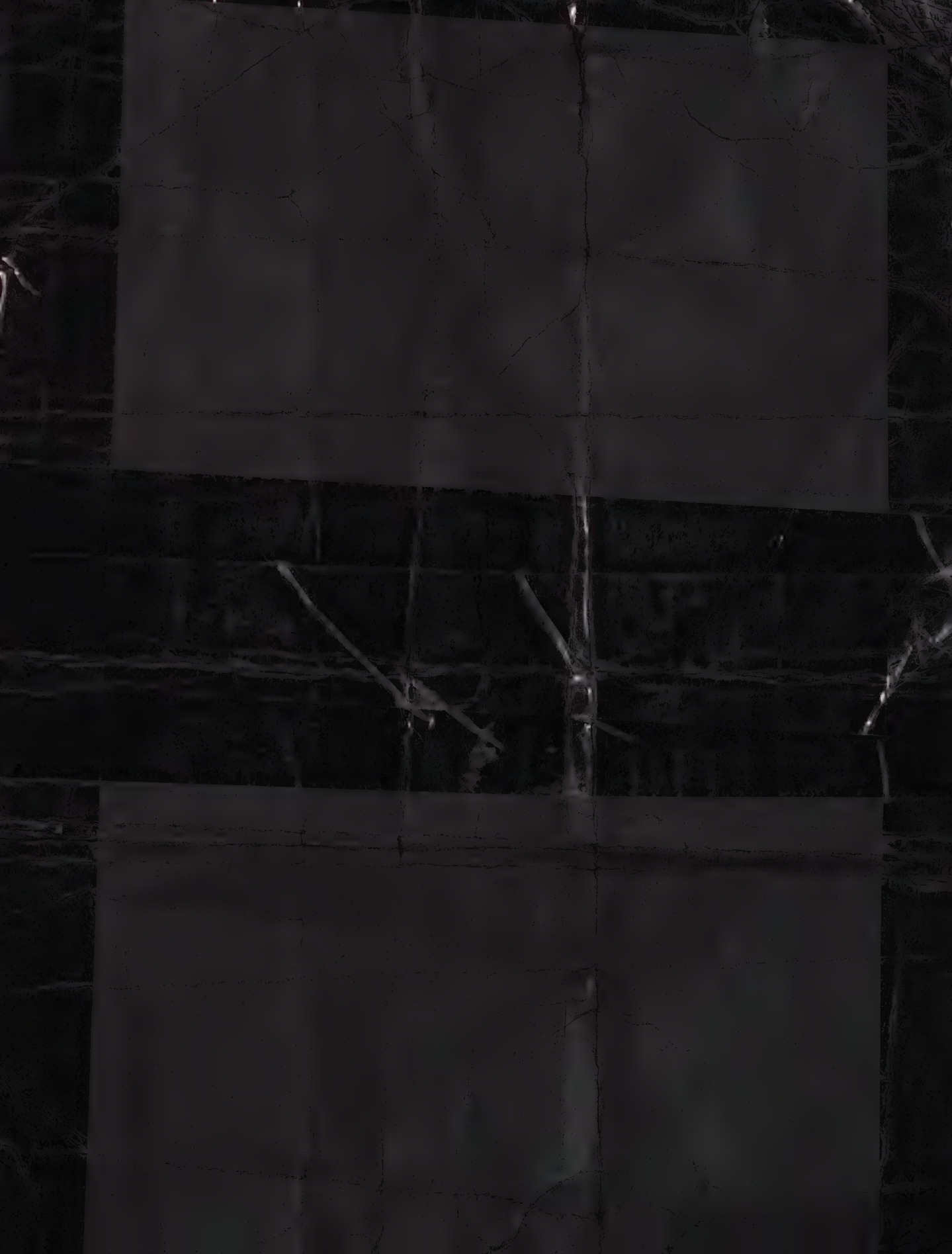


Figure 7—3. Power Supplies Functional Diagram





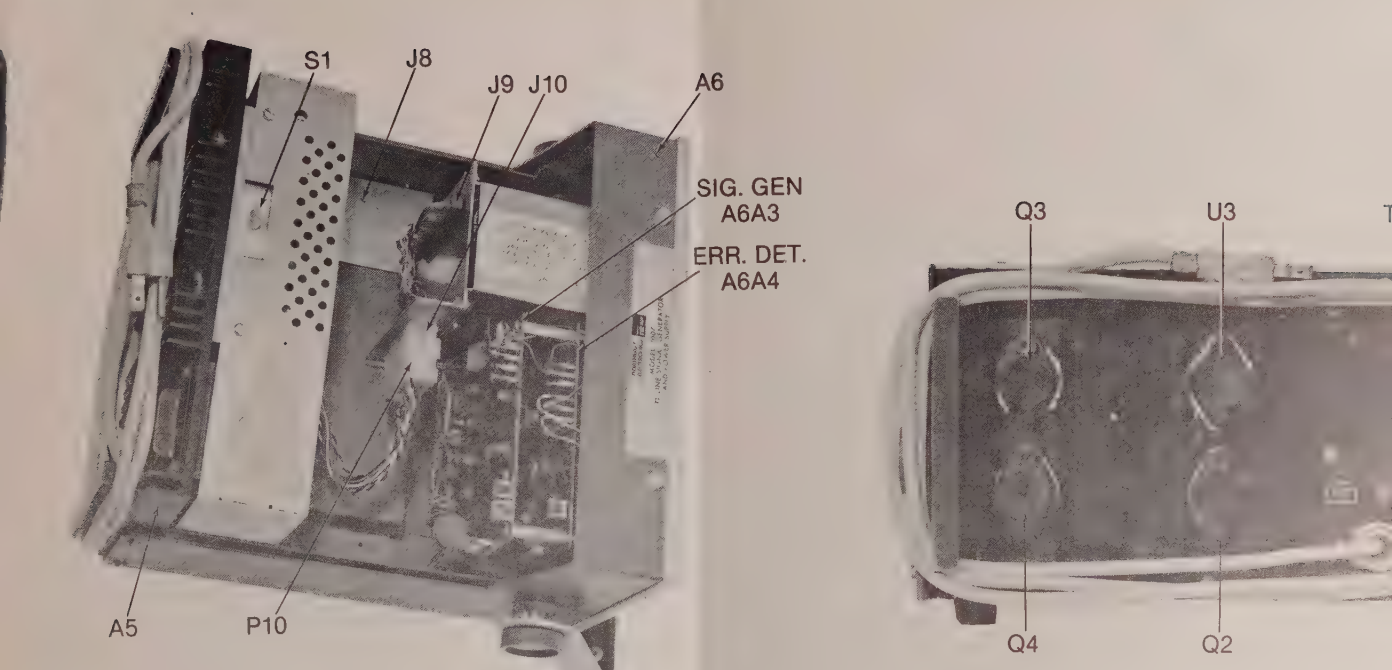


Figure 7—4. Model 7007 Major Component Location

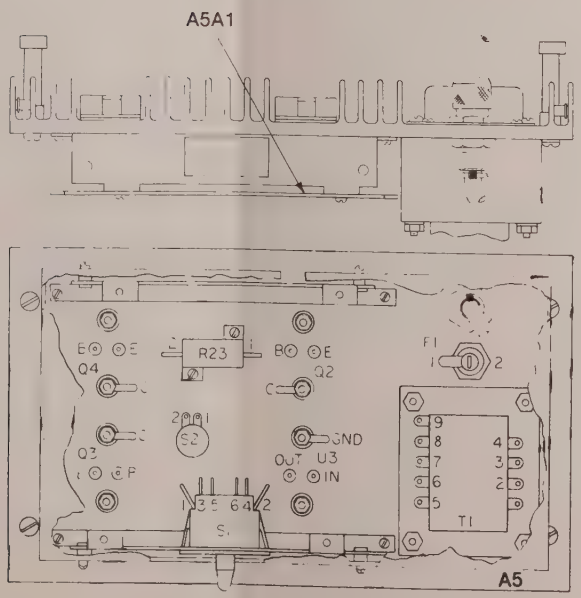


Figure 7—5. Power Supply Assembly A5
Component Location

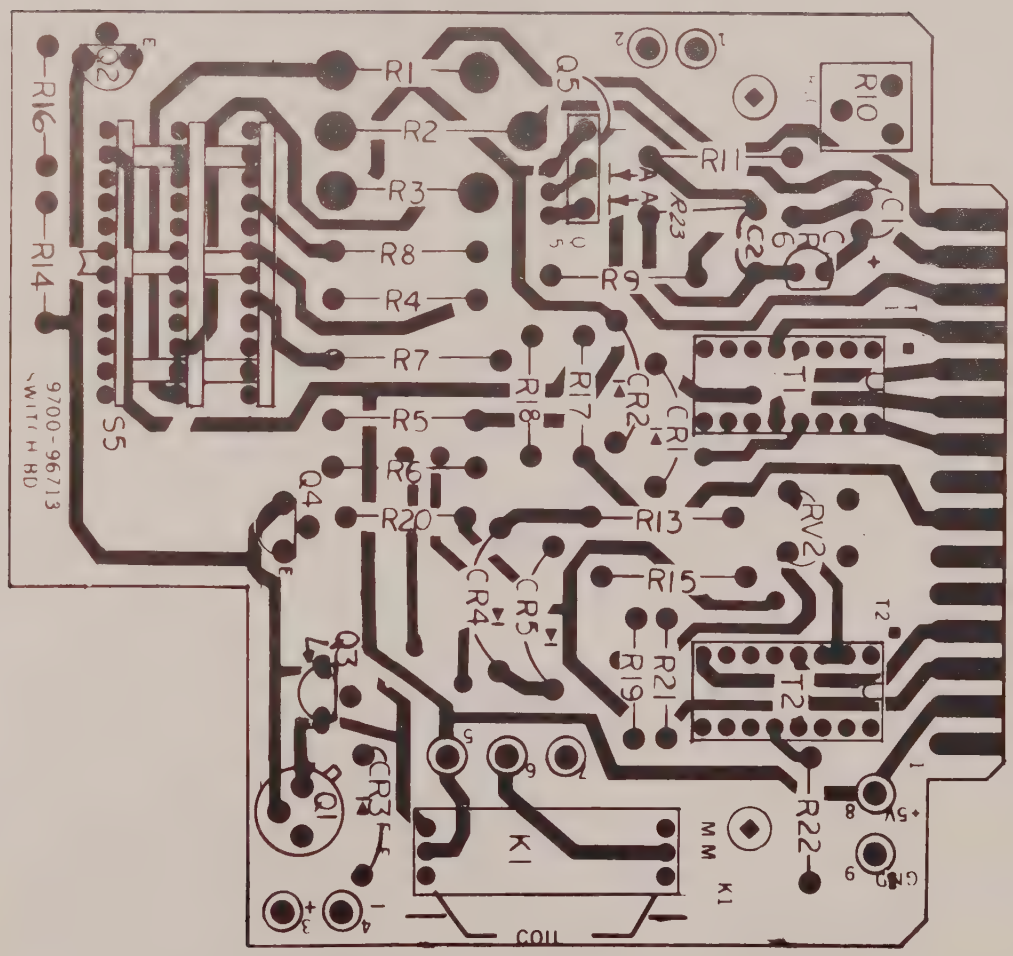
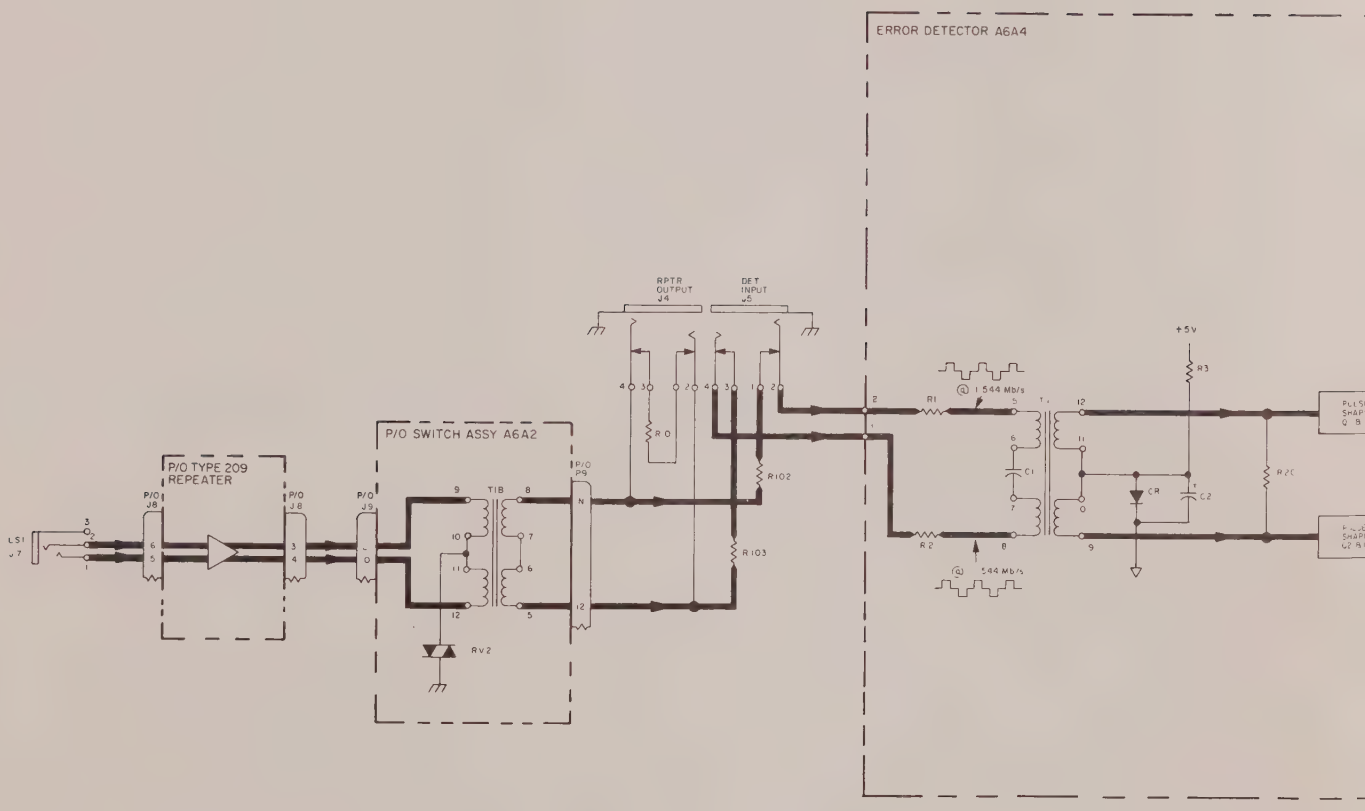


Figure 7—6. Switch Assembly A6A2 Component Location


ERROR DETECTOR A6A4
P/O TYPE 209 REPEATER
P/O SWITCH ASSY A6A2
RPTR OUTPUT J4
DET INPUT J5
P/O J8
P/O J8
P/O J9
P/O P9
TIB
R0
R102
R103
RV2
R1
R2
R3
C1
C2
CR
+5v
1.544 Mb/s
1.544 Mb/s

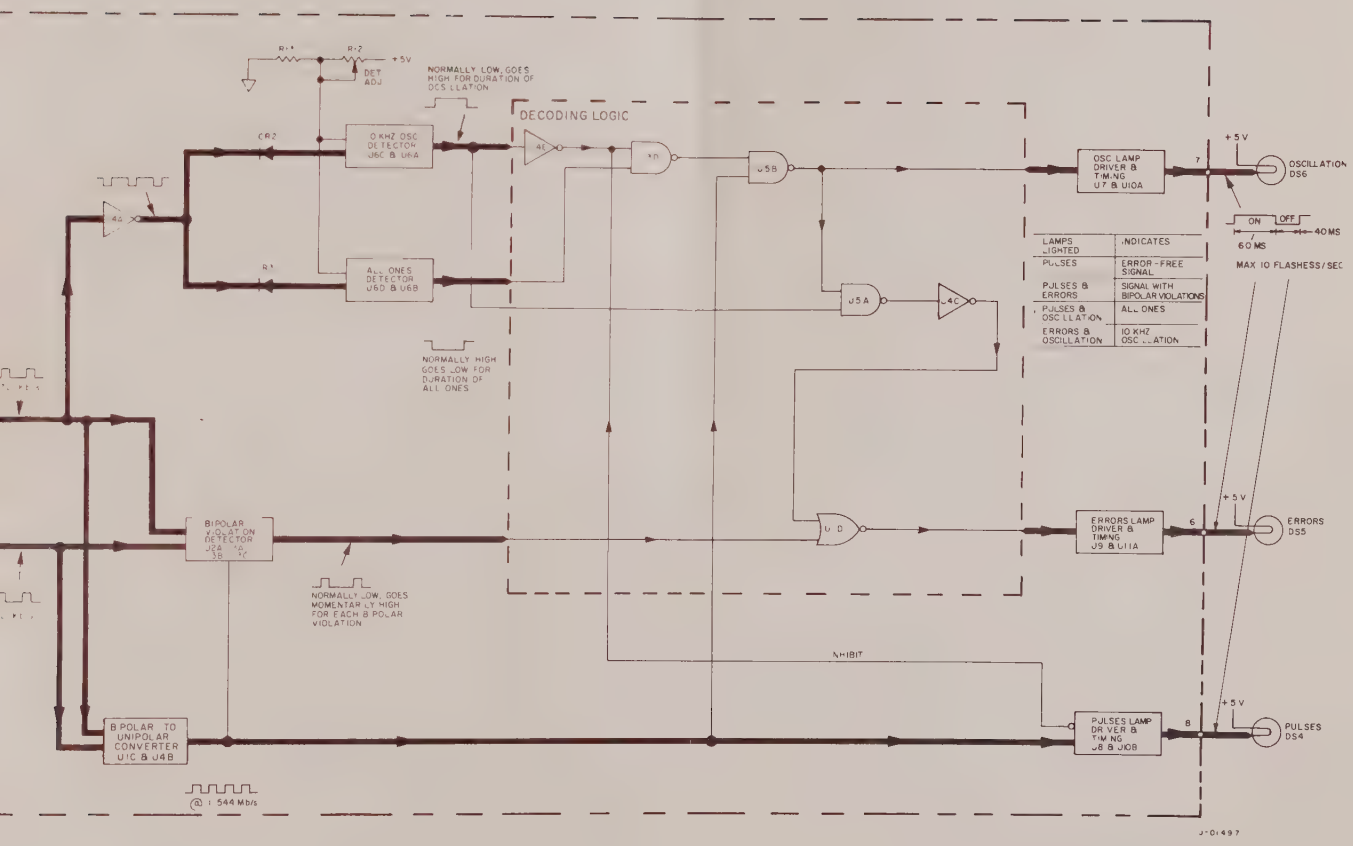
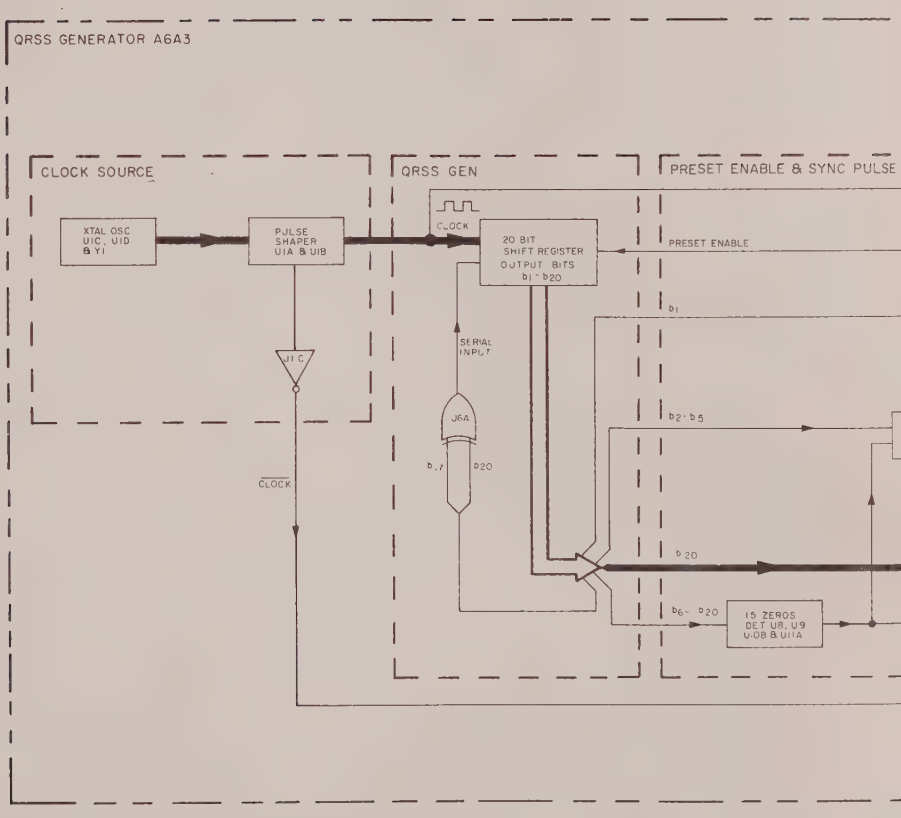

DECODING LOGIC
NORMALLY LOW, GOES HIGH FOR DURATION OF OSCILLATION
NORMALLY HIGH GOES LOW FOR DURATION OF ALL ONES
NORMALLY LOW, GOES MOMENTARILY HIGH FOR EACH BIPOLAR VIOLATION
10 KHZ OSC DETECTOR U6C & U4A
ALL ONES DETECTOR U6D & U6B
BIPOLAR VIOLATION DETECTOR U2A TO U2C
BIPOLAR TO UNIPOLAR CONVERTER U1C & U4B
OSC LAMP DRIVER & TIMING U7 & U10A
ERRORS LAMP DRIVER & TIMING U9 & U11A
PULSES LAMP DRIVER & TIMING U8 & U10B
OSCILLATION DS6
ERRORS DS5
PULSES DS4
+5V
ON
OFF
40 MS
60 MS
MAX 10 FLASHES/SEC
LAMPS LIGHTED | INDICATES
PULSES | ERROR-FREE SIGNAL
PULSES & ERRORS | SIGNAL WITH BIPOLAR VIOLATIONS
PULSES & OSCILLATION | ALL ONES
ERRORS & OSCILLATION | 10 KHZ OSCILLATION
@ 1.544 Mb/s

Figure 7—2. Error Detector Functional Diagram


QRSS GENERATOR A6A3
CLOCK SOURCE
QRSS GEN
PRESET ENABLE & SYNC PULSE
XTAL OSC
U1C, U1D
& Y1
PULSE
SHAPER
U1A & U1B
CLOCK
20 BIT
SHIFT REGISTER
OUTPUT BITS
b1 - b20
PRESET ENABLE
b1
SERIAL
INPUT
J1C
J6A
b2 - b5
b 20
CLOCK
b6 - b20
15 ZEROS
DET U8, U9
U.OB & U11A

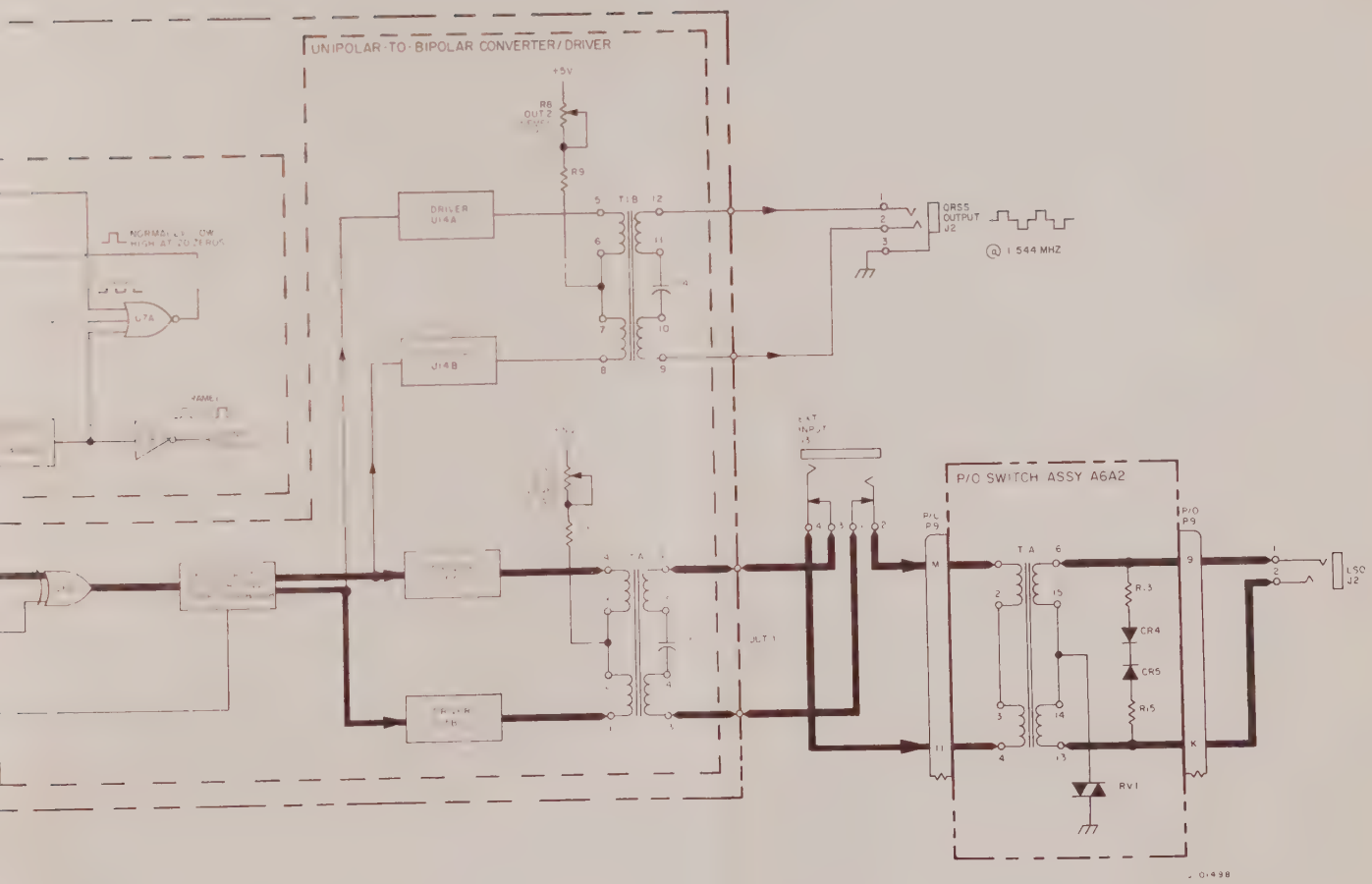


Figure 7—1. QRSS Generator Functional Diagram

SECTION 8

ELECTRONIC PARTS LIST

8.1 INTRODUCTION

8.2 This section contains the electronic parts lists for the Model 7007. Each parts list is arranged alpha-numerically by reference designator.

Table 8—1. Model 7007 Overall Parts List (Figure 7—4)

REFERENCE DESIGNATOR	DESCRIPTION VALUE POWER TOL VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
A5	POWER SUPPLY ASSY			A700700012
A6	FRONT PANEL ASSY			A700700017
A7	CONNECTOR COVER DETAIL			A700700105
A8	CHASSIS ASSY			A700700114
F2	FUSE 3AG	LITTELFUSE 3AG		863100101

Table 8—2. Power Supply Assembly A5 Parts List (Figure 7—5)

REFERENCE DESIGNATOR	DESCRIPTION VALUE POWER TOL VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
A1	PC BD 96700 POWER SUPPLY			A700700013
F1	FUSE SLO-BLO	BUSSMAN	MDL	863101400
P10	16 COND	AMP	1-480438-0	650900800
Q2-4	TO-3 50W TC NPN 900V	DELCO	DTS 708	550000708
R23	1500 25 WATT 10%	VARIOUS	RE70 TYPE	210901526
S1	INTLK SWITCH W/O CHEAT	CHERRY	E79-00A	600000002
S2	190F OUT 160 F IN	ELMWOOD	3001-1E-90	805001401
T1	60HZ	PROFILE	SEE SPEC.	420500001
U3	TO-3 5V	FAIRCHILD	7805KC	500078051
XF1	FUSEHOLDER,3AG PANEL	BUSSMAN	HKP	863000100

Table 8—3. Power Supply Circuit Board A5A1 (96700) Parts List (Figure 7—6)

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C1	500UF			50V	SPRAGUE	39D507G050GL4	300005071
C2-3	100UF			300V	SPRAGUE	39D107F300HP4	300001072
C4	800MF			25V	SPRAGUE	39D807G025JE4	300008070
C5	10UF		10%	10V	KEMET	T330A106K010AS	310001060
C6	.01UF	Z5UTC	GMV	1KV	CENTRALAB	CD-103	330101030
C7	.1UF		OO	75V	CENTRALAB	DDA-104	330201040
C8	.1UF		20%	500V	SPRAGUE	5GA-P10	330401040
C9-10	4UF			350V	SPRAGUE	39D405F350EE4	300004050
C11	.1UF		20%	500V	SPRAGUE	5GA-P10	330401040
CR1-12	DO41	1A	SI	600V	EDAL	IN4005	560040050
CR13	A1AY	1W	5%	20V	MOTOROLA	1N4747A	562047470
CR14-20	DO41	1A	SI	600V	EDAL	IN4005	560040050
CR21	A1AY	1W	10%	5.1V	MOTOROLA	1N4733	562047330
CR22	A1EE	5W	5%	120V	MOTOROLA	1N5380B	562053802
CR23	DO7	250MW	5%	6.8V	DICKSON	1N710A	562007109
CR24	DO41	1A	SI	600V	EDAL	IN4005	560040050
K2	M/O 4V	32-40MA		6V	MIDTEX	172-221-BA1	604106900
Q1	TO-5	1W TA	NPN	65V	RCA	2N2102	550021020
Q5	CASE77	20.8W TC	NPN	200V	MOTOROLA	MJE344	550000344
R1	150-	1/2W	10%		AB	TYPE EB	200201516
R2-3	150K	1/2W	10%		A.B.	TYPE EB	200201546
R4	3320-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220233211
R5	1K	.75W	10%		HELIPOT	89PR1K	232501020
R6	301K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220230131
R7	25K	5W	10%		W LEONARD	TYPE 5XM	210402536
R8-9	3.92K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220239211
R10	22K	1/2W	10%		AB	TYPE EB	200202236
R12	1820-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220218211
R13	825-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220282501
R14	4.7K	1/2W	10%		AB	TYPE EB	200204726
R15	5.62K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220256211
R16	1000-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220210011
R16	1K	1/2W	10%		HELIPOT	72XR1K	232701029
R17	470-	1/2W	10%		AB	TYPE EB	200204716
R18	390-	1/2W	10%		AB	TYPE EB	200203916
R19	1K	1/2W	10%		AB	TYPE EB	200201026
R20	47-	1/2W	10%		AB	TYPE EB	200204706
R21	120-	1/2W	10%		AB	TYPE EB	200201216
R22	470-	1/2W	10%		AB	TYPE EB	200204716
R24	30-	5W	5%		W LEONARD	TYPE 5XM	210403005
R25	330K	1/2W	10%		AB	TYPE EB	200203346
R26	2K	.75W	10%		HELIPOT	89PR2K	232502020
R27	220-	1/2W	10%		AB	TYPE EB	200202216
R28	56-	3W	5%		W LEONARD	TYPE 3X	210305605
R29	5K	3W	5%		W LEONARD	TYPE 3X	210305025
U1-2	14 DIP	150 MA			FAIRCHILD	UA723PC	500000723
XU1-2	14DILP				SCANBE	ME2L14	820100301

Table 8—4. Front Panel Assembly A6 Parts List (Figure 7—4)

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
A2	PC BD 96713 SWITCH						A700700016
A3	PC BD 96698 GENERATOR						A700700014
A4	PC BD 96742 ERROR DET						A700700015
DS1	AMBER				DRAKE /CM	6183-100-603	828002700
DS2	LED,HI EFF.RED				H.PACKARD	5082-4656	564500801
DS3-6	LAMP,BI-PIN CART.				SYL	905	730003600
F2	FUSE 3AG				LITTELFUSE	3AG	863100101
J2	MT332B				SWCRFT	5J-1583	650403100
J3-5	N/P				SWCRFT	5J-1594	650403200
J6-7	MT332B				SWCRFT	5J-1583	650403100
J10	16 COND				AMP	1-480439-0	650800001
M1	METER,100 DEG,7007				JEWEL INST	82T / SPECIAL /	901100402
R101	100-	1/4W	10%		AB	TYPE CB	200101016
R102-103	430-	1/2W	5%		AB	TYPE EB	200204315
S3	DPDT	6A		125V	J-B-T	ST22N	620100600
S4	SPST	10A		115V	GRAYHILL	2201	635500800
W1	HARNESS LAYOUT						A700700011
XDS2	LED MTG. CLIP FOR T1 3/4				VISUAL COM	CLE-280-RTP	850501101
XDS3-6	SOCKET,CART LAMP,SHORT				SYL	SM-1	828002300
XF2	FUSEHOLDER,3AG PANEL				BUSSMAN	HKP	863000100

Table 8—5. Front Panel Assembly Wiring Harness A6W1 Parts List (Figure 7—4)

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
J5	TYPE 1A 15 DUAL MIL PLWS				AMPHENOL	225-21521-101	651701500
J8	12 POS 150 CTRS				LYNCH COMM	5935-0042	653500300

Table 8—6. Switch Circuit Board A6A2 (96713) Parts List (Figure 7—6)

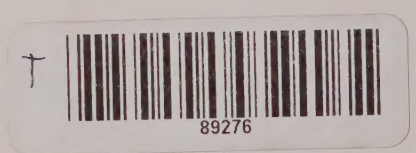
REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C1	1UF		10%	35V	KEMET	T330A105K035AS	310001051
C2	.01UF		00	50V	CENTRALAB	CK-103	330701030
CR1-3	D041	1A	SI	600V	EDAL	IN4005	560040050
CR4-5	BV 7.35V		5%		GEN SEMI	G760309A	565500003
CR6	CASE 182	100UA	16V	24V	MOTOROLA	1N5758A	562005758
K1	M/O 4V	32-40MA		6V	MIDTEX	172-221-EA1	604106900
Q1	TO-5	1W TA	NPN	65V	RCA	2N2102	550021020
Q2-4	TO-92	350MW TA	NPN	40V	MOTOROLA	2N3903	550039030
Q5	90-04	IT8A	2A	10V	MOTOROLA	2N4444	556044440
R1	10-	2W	1%		TEL LAB	EL-2F	2102100?1
R2	68-	3W	5%		W LEONARD	TYPE 3X	210306805
R3	10-	2W	1%		TEL LAB	EL-2I	2102100?1
R4	316K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220231631
R5	2940-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220229411
R6	2870-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220228711
R7	634K	3/4W	1%		VARIOUS	RN70 SIZE 100 PPM	222363431
R8	316K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220231631
R9			** NO FIXED **				200202745
R9	270K	1/2W	10%		AB	TYPE EB	200202746
R10	20K	1/2W	10%	200V	HELIPOT	72PMF20K	232702032
R11	13.3K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220213321
R13	56-	1/2W	5%		AB	TYPE EB	200205605
R14	2.2K	1/4W	10%		AB	TYPE CB	200102226
R15	56-	1/2W	5%		AB	TYPE EB	200205605
R16-20	10K	1/4W	10%		AB	TYPE CB	200101036
R21-22	100-	1/4W	10%		AB	TYPE CB	200101016
RV2	VARISTOR,MET OXIDE				G.E.	V150ZA1	565500150
S5	6 POS.	60 DEG			OAK	5-23271-738(A3PCB)	625600003
T1-2	16DILP				ARTTED	AC8326	440200100

Table 8—7. QRSS Generator Circuit Board A6A3 (96698) Parts List (Figure 7—8)

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C1-2	.047UF		10%	100V	SPRAGUE	225F47391WD3	320004730
C3-4	.1UF		20%	500V	SPRAGUE	5GA-P10	330401040
C5	22UF		10%	6V	KEMET	T330A226K006AS	310002260
C6-17	.01UF		20%	16V	CENTRALAB	UK16-103	330701031
E1-8	PIN QUICK DISC MALE PC				AMP	61036-1	863400800
R1-2	10K	1/4W	10%		AB	TYPE CB	200101036
R3	1K	1/4W	10%		AB	TYPE CB	200101026
R4	470-	1/4W	10%		AB	TYPE CB	200104716
R5	18K	1/4W	10%		AB	TYPE CB	200101836
R6	100-	1/2W	10%		HELIPOT	72XWR100	232701013
R7	47-	1/4W	10%		AB	TYPE CB	200104706
R8	100-	1/2W	10%		HELIPOT	72XWR100	232701013
R9	47-	1/4W	10%		AB	TYPE CB	200104706
T1	16DILP				ARTTED	AC8326	440200100
U1	14DIP-P			UTL	SIGNETICS	SP380A	510003800
U2-5	16DIP-P			TTL	TI	SN7496N	510074960
U6	14DIP-P			TTL	TI	SN7486N	510074860
U7-9	14DIP-P			TTL	TI	SN7425N	510074250
U10	14DIP-P			TTL	TI	SN7420N	510074200
U11	14DIP-P			TTL	TI	SN7404N	510074040
U12	14DIP-P			TTL	TI	SN7473N	510074730
U13	14DIP-P			TTL	TI	SN7410N	510074100
U14-15	8DIP-P			DS	TI	SN75451BP	510075451
XY-1	SKT				AUGAT	8000-DG3	826500100
Y-1	CRYSTAL SKT MTG				VALPEY	VR6-1.544MHZ	919100500

Table 8—8. Error Detector Circuit Board A6A4 (96742) Parts List (Figure 7—10)

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C1	.1UF		20%	500V	SPRAGUE	5GA-P10	330401040
C2	10UF		10%	10V	KEMET	T330A106K010AS	310001060
C3-4	100PF		2%	500V	ARCO	CM04FD101G0	335401010
C5	1UF		10%	35V	KEMET	T330A105K035AS	310001051
C6	.01UF		1%	100V	PDYNE	PPA-11-.01-100-1	322401030
C7	.001UF		1%	100V	P-DYNE	PPA-11-.001-100-1	322401020
C8-13	10UF		10%	10V	KEMET	T330A106K010AS	310001060
C14	22UF		10%	6V	KEMET	T330A226K006AS	310002260
C15-23	.01UF		20%	16V	CENTRALAB	UK16-103	330701031
CR1	OUTL.15	250MW		100P	H PACKARD	5082-2800	561550820
CR2-3	A16Z	80MW	GE	50V	TRANS.	1N198	561001980
E1-8	PIN QUICK DISC MALE PC				AMP	61038-1	863400800
Q1-2	TO-18	300MW	TA	NPN	24V GE	2N706A	550007060
R1-2	316-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220231601
R3	5110-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220251111
R4-5	4.7K	1/2W	10%		AB	TYPE EE	200204726
R6	237K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220223731
R7	13.3K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220213321
R8	4220-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220242211
R9	27.4K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220227421
R10-11	4.7K	1/2W	10%		AB	TYPE EE	200204726
R12	10K	1/2W	10%	200V	HELIPOT	72XWP10K	232701031
R13	10K	1/2W	10%		AB	TYPE EB	200201036
R14	16.2K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220216221
R15	31.6K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220231621
R16	16.2K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220216221
R17	31.6K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220231621
R18	16.2K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220216221
R19	31.6K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220231621
R20	1470-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220214711
T1	16DILP				ARTTED	AC8326	440200100
U1	14DIP-P			TTL	TI	SN7402N	510074020
U2	14DIP-P			TTL	TI	SN7473N	510074730
U3	14DIP-P			TTL	TI	SN7400N	510074000
U4	14DIP-P			TTL	TI	SN7404N	510074040
U5	14DIP-P			TTL	TI	SN7400N	510074000
U6	14 DIP				NAT.SEMI	LM339N	500000339
U7-9	16DIP-P			DM3	FAIRCHILD	9602PC	510096025
U10-11	8DIP-P			DS	TI	SN75451BP	510075451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